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F. A. BROCKHAUS, LEIPSIC, and
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GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, F.G.S., DIRECTOR.

PALÆOZOIC FOSSILS.

VOL. II, PART I.

BY E. BILLINGS, F.G.S.
PALÆONTOLOGIST, G.S.C.

Montreal:
DAWSON BROTHERS.
August, 1874.

The second volume of the Palæozoic Fossils of Canada, like the first volume issued in 1865, will contain :

1. Descriptions of new species of Palæozoic Fossils.
2. Re-descriptions of species which have been published by Mr. Billings from time to time in the "Canadian Naturalist," the "Geological Magazine" and the "American Journal of Science."
3. Investigations relating to the structure and classification of some of the extinct groups.

The part now presented, consisting of 144 pages of descriptive text, with 85 woodcuts and ten lithographed plates, contains :

1. Description of fossils from the Silurian and Devonian rocks of Gaspé.
2. Descriptions of new species from the Primordial rocks of Newfoundland.
3. On the genus *Stricklandia*.
4. Notes on the structure of the *Crinoidea*, *Cystidea* and *Blastoidea*.
5. Descriptions of fossils from the Upper Silurian rocks of Arisaig, Nova Scotia.

The woodcuts are by Mr. J. H. Walker, of Montreal, from drawings by the late Mr. H. S. Smith. The lithographed figures, plates I to IX, were all drawn from nature and lithographed by Mr. A. H. Foord, F.G.S., the artist to the Survey. Part II, the figures and descriptions for which are in course of preparation, will be published as early as practicable.

ALFRED R. C. SELWYN.

GEOLOGICAL SURVEY OFFICE,
Montreal, 15th July, 1874.

GEOLOGICAL SURVEY OF CANADA.

PALÆOZOIC FOSSILS.

VOL. II, PART 1.

1. *On some of the Fossils of the Gaspé series of rocks.*

At Cape Gaspé, and in the neighborhood, the rocks described in the Geology of Canada, as "The Gaspé Series," occur, in the descending order, as follows:

THE GASPE SANDSTONES.

Sandstones interstratified with arenaceous and calcareous shales. For full details, see "Geology of Canada," p. 394 to 397. Thickness 7036 feet.

THE GASPE LIMESTONES.

Devonian.	8. Grey limestones, in beds of from six to twelve inches thick, some of them holding chert at the summit	500
	7. Grey nodular shaly limestone with greenish calcareo-arenaceous shales at the top	300
Passage Beds.	6. Grey calcareous shales or shaly limestone, interstratified, particularly at the top, with beds of purer limestone fit for burning	300
	5. Grey, greenish, and dark grey calcareous shales, with beds of arenaceous limestone	380
	4. Grey limestones in thin beds with some olive-green shales	200
	3. Olive-green calcareo-argillaceous shales, with nodules and layers of compact limestone	170
Upper Silurian.	2. Greenish calcareo-argillaceous shales, which are interstratified with less calcareous layers, of various shades of red	90
	1. Grey limestones in layers of from six to eight inches thick, which are separated by bands of greenish calcareo-argillaceous shale, gradually increasing in amount towards the top	70
		9010

The following account of the distribution of the Gaspé limestones and shales is taken from the "Geology of Canada," p. 393, 394.

"These strata dip south-west at an angle of twenty-four degrees, and are beautifully seen in the cliffs; which present a vertical naked face nearly 700 feet in height, on the north-east side of Gaspé promontory. The lowest limestones, 1, constitute the first step in the mountains encountered in passing from Cape Rosier to Grand Grève. The second hard calcareous band, 4, forms another step in the same ascent; it makes also Cape Bon Ami, from which the grey calcareous shales, 5, present a steep slope, up to the grey shaly limestones, 6. These rise in a vertical and sometimes overhanging escarpment, up to the edge of the precipice; from which the harder beds that form the summit of the above section, slope down into a valley. This valley divides the hills of the promontory into a double range, and maintains its character with some constancy further into the interior.

"From this valley, the succeeding members of the series are piled in a second escarpment, and constitute the loftier of the two ranges." The rocks of this part consist of divisions, 7 and 8.

The entire volume of these limestones is about 2000 feet. The two lower divisions (1 and 2) are most probably Silurian; about the age of the Helderberg of the New York Geologists. The upper two members (7 and 8) are nearly of the age of the Oriskany sandstone, and are, therefore, about the base of the Devonian. Divisions 4, 5, 6, may be regarded as constituting passage beds between the Upper Silurian and Devonian.

"They occupy the whole of the promontory of Cape Gaspé, which extends from the mainland for a distance of about seven miles, with a breadth of no more than seven-tenths of a mile: except at its junction with the lower band extending to Cape Rosier, where it gradually assumes a greater breadth. They skirt the north-east bank of the north-west arm of Gaspé Bay, and the left bank of Dartmouth River; constituting a range of mountains, some of whose summits, according to Bayfield, are about 1500 feet high. From Little Gaspé they are flanked by a strip of the succeeding formation, the junction of the two being seen at Little Gaspé Cove. About seventeen miles above Little Gaspé these limestones cross the north branch of the Dartmouth, upwards of two miles from the mouth of the tributary; on which a partial section, directly across the measures, presents a thickness of 1800 feet. At the bottom of this, there are interstratified layers of chert, which have not yet been observed at Cape Gaspé."

Distribution of the Gaspe Sandstones.

(From the Geology of Canada, p. 394 to p. 400.)

Succeeding the calcareous rocks just described, and resting upon them conformably, there occurs an important group of sandstones. The contact of the two series, as already stated, is seen at Little Gaspé; but between the visible base of the sandstone group and the place of its greatest development, there are two considerable undulations, and a probable dislocation, of an uncertain amount. These render it difficult as yet to unite the whole series, with a certainty that no strata are repeated or left out. But though the section which shows the greatest unbroken series of strata, does not reach to the base, it is probably not far removed from it; and it may, therefore, for the present, be assumed, probably without much inaccuracy, to represent the whole group. In ascending order, the strata are as follows:—

	Feet.
1. Grey arenaceous and argillaceous shales, with beds of grey sandstone, varying in thickness from one to twenty feet, and one of them seventy-five feet. A three-inch band of argillaceous iron ore occurs about a hundred feet from the top. Towards the bottom, the beds weather of a rusty brown color, and contain abundance of plants. One of these, in its arrangement on the surface of the beds, resembles *Fucoides graphica*, but it may be the broken roots or stems of the other species of plants, which have been recognized in this deposit; surfaces thus characterized were met with in more than one locality. Many of the beds abound with the comminuted remains of carbonized plants, most of which are too obscure to be determined. Among them, however, are *Prototaxites Logani*, *Lepidodendron Gaspianum*, *Psilophyton princeps*, *P. robustius*, *Selaginites formosus*, and *Cordaites augustifolia*; all described by Dr. Dawson. Towards the lower part, there is a small seam of coal, with carbonaceous scale, measuring together about three inches; which appears to hold a regular course, having a bed of clay beneath, marked by what seem to be the roots of *Psilophyton*; while the stems and leaflets of the plant are met with in a thin seam of shale above the coal, and in the carbonaceous shale associated with it. On some of the leaflets, small shells of the genus *Spirorbis* are met with. More than 130 feet above the coal seam, there is a hard rough grey bed, looking like fire-clay; with the fibrous impressions of *Psilophyton* roots penetrating it at right angles. Ripple-mark occurs on some of the surfaces.....	528
2. Drab sandstones, many of them with a reddish tinge; they present spheroidal masses harder than the general character of the rock, and are marked by extensive ferruginous stains. A few scattered pebbles of quartz and jasper occur in some of the beds, which are in general thick, and separated from one another by layers and partings of grey argillaceous and arenaceous shale. Nodules of argillaceous iron ore are contained in some of the layers, and comminuted carbonized plants are frequently seen on the divisional surfaces; those which have been determined belong to the species already mentioned.....	916
3. Drab sandstones, inclining to reddish at the bottom and greenish at the top; with occasional scattered quartz and jasper pebbles, and large spheroidal masses, as above. Ferruginous stains are frequent, and the	

beds, usually massive, are separated by layers of grey argillo-arenaceous shale, which, as well as the sandstones, sometimes contain nodules of argillaceous iron ore. In the middle and lower part, there are interstratified two conspicuous beds of claret-red, green, and dark grey argillo-arenaceous shale; in the upper one of which are two, and in the lower, eight bands of a grey tough rock, much like fire-clay, penetrated vertically by the rootlets of *Psilophyton*..... 428

4. Drab sandstones, inclining to green; some of which contain quartz and jasper pebbles; many parts have large hard spheroidal masses, as before. The beds are in general very thick, and they are separated by layers of grey argillaceous shale, from which large argillaceous masses occasionally protrude into the superincumbent sandstone, some of these being as much as three feet high and as broad. Comminuted carbonized plants, similar to those already named, occur on the surfaces of the lower beds..... 2052

5. Drab sandstone; in massive beds, in only a few of which there are scattered quartz and jasper pebbles. The sandstones are interstratified with five conspicuous bands of claret-red, green, and grey argillo-arenaceous shale, of an aggregate thickness of 140 feet..... 442

6. Drab strong and coarse conglomerates, in massive beds, one of them 156 feet thick. The pebbles of these consist of white quartz, black chert, yellow, green, and blood-red jaspers, and jasper porphyry; with which are sometimes found others of feldspar and of limestone, the whole enclosed in a matrix of drab-colored sandstone. In some portions of the deposit, the pebbles diminish in quantity so that the rock becomes a rather fine-grained sandstone, with only occasional pebbles. The carbonized comminuted remains of plants occur on the surfaces of the beds, and in their oblique elementary layers or false bedding. Among the organic remains of this division, fishspines or ichthyodorulites occur, of the genera *Onchus* and *Machæracanthus;* one of them, the *M. Sulcatus* of Newberry..... 856

7. Red sandstones, sometimes slightly calcareous, with green stripes and spots, many of the beds massive; associated with occasional drab sandstones, and with two thin bands of conglomerate, holding pebbles of quartz, jasper and limestone. All of these are interstratified with red argillaceous and arenaceous shales, spotted and striped with green. In many cases, the sandstones exhibit on their under surfaces, highly relieved casts of shrinkage cracks and of rain drops, and on the upper surfaces ripple-marks. The shales are sometimes penetrated by branching plants, in vertical, oblique, and prostrate attitudes; while one or two beds have fibrous root-like impressions, probably of *Psilophyton*, running across them at right angles..... 1151

8. Drab massive sandstones, which in the lower part are clouded or mottled with a reddish tinge, and at the bottom exhibit an interstratification with red shales; at the summit the beds are inclined to grey. In many parts, they hold scattered pebbles of white and greenish quartz, and blood-red jasper, with some of limestone; but the pebbles never become so numerous as to constitute a conglomerate. On the surfaces of many of the strata, and in the oblique elementary layers or false bedding of some of them, there occur carbonized comminute remains of plants; which are too imperfect to be determined..... 663

7036

The lower portions of this great series of sandstones are met with in Little Gaspé Cove; where, in addition to the various species of fossil plants already mentioned, are found the remains of what appears to be a species of *Calamites;* one specimen of which shows a flattened stem four feet long, with a breadth of four inches. The inferior portion of the formation skirts the north-eastward side of Gaspé Bay, and the North-West Arm, from the cove, as far as the north branch of Dartmouth River; where it occupies a breadth of about 9000 feet, across the measures; giving, at an average dip of twenty-six degrees, a thickness of about 4000 feet. On the south-west side of Gaspé Bay, in the neighborhood of Gaspé Basin, the same strata rise with an opposite and more precipitous slope, forming a trough under the bay. The thickness there exposed is again about 4000 feet. The same beds next fold over an anticlinal axis, which comes out upon the bay near Cape Haldimand; then, dipping at a very moderate angle on the south-west side of the axis, beneath the lagoon at the mouth of the River St. John, they re-appear, with a nearly opposite slope, at the south-eastern end of Douglastown Village, and exactly face Great Cape Oiseau (Cap Brulé of Bayfield's chart) and Little Gaspé, on the north-east side of the bay. Following the coast, they exhibit a slight sinuosity in Seal Cove (Bréhaut Bay of Bayfield); and at the extremity of Tar Point, between this cove and the next one farther on, they fold over another anticlinal axis; the position of which is indicated by a remarkable greenstone dyke, holding petroleum. The direction of both of these anticlinals is nearly north-west and south-east.

It is from this point to the termination of the series, in the cove immediately northward of Pointe Jaune or Yellow Head, that the strata given in the vertical section are found. The coast cuts them obliquely; and in every step south-eastward from Tar Point, higher strata are met with, in advancing, until Long Cove is reached, where the red sandstones are seen. In this cove, the measures have a very moderate inclination, and a slight protrusion in the line of strike causes the coast section of the cliff to present a gentle arch in the centre, repeating a part of the beds. Farther on, the section still gains upon the strata, in the vicinity of Red Head, and beyond it; until they are suddenly cut off by a fault, at the spot already indicated as the termination of the series. Throughout the whole distance, the strata are seldom concealed; and though several small faults occur, the allowance that is to be made for them may be seen in the cliff, which is generally bold.

The two anticlinals which have been mentioned, appear to run parallel, as well to the mountain ranges of the neighborhood, as to the calcareous rocks on the north-east side of Gaspé Bay. They may be about three

miles asunder in a direct line. The northern one is traceable for seven miles, from the vicinity of Cape Haldimand to the inner basin at Gaspé; which it crosses about 350 yards south-west of the Narrows at the entrance. It brings to the surface, on the north side of the basin, some beds of sandstone, which are rendered calcareous by an abundance of fossils. The beds to the north-east of these, along the south-west side of Gaspé Harbor and Bay, as already indicated, are upwards of 4000 feet higher in the series. They contain a few interstratified bands of a red color near the top, some of them with casts of shrinkage cracks: and along the strike, between Pointe Lourde and Cape Haldimand, some of the best characterized specimens of the land plants of the formation are to be obtained. In the upper 760 feet, eight beds are seen to be marked by the vertical rootlets of *Psilophyton:* and on one of these, two hundred of the rootlets were counted in a square of six inches.

The mark which has been taken as indicating the direction of the southern anticlinal axis, is the course of the greenstone dyke in its vicinity; this, however, has as yet been traced only a short distance, as it soon becomes covered up, after striking into the forest. It is probable that this dyke is connected with a dislocation, throwing down the measures to the north-eastward. It is not easy, however, to say how much higher in the series the beds on that side may be, than those on the south-west. The latter are, as has already been stated, at the base of the 7036 feet of strata given in the vertical section; while on the north-east side, between Tar Point and Douglastown, a section of 3800 feet was observed, after which the summit of the series became concealed. At about 500 feet from the base of this section, there are met with the remains of a coniferous tree, described by Dr. Dawson under the name of *Prototaxites Logani*. The stem of one of these, obtained by Dr. Dawson, must have been twelve inches in diameter, before it became compressed. About 600 feet still higher among these strata, several surfaces in succession are marked by serpentining impressions, about an inch wide, deeply grooved into the stone, marked by small parallel transverse furrows, which are about a quarter of an inch apart. These are perhaps worm-tracks, and are associated with a few bivalve shells of the genus *Rensselæria*, probably *R. ovoides*. All of these strata, and most of those above them, in which sandstone greatly predominates over shale, are in general drab-colored, though some are grey. Many of the surfaces are marked by carbonized comminuted plants, similar to those which have already been mentioned; and argillaceous iron ore occurs in nodules in several beds, about the middle of the mass.

The dips on the north-east side of both of these anticlinal flexures are

more precipitous than those on the south-west. In this they accord with the general character of the undulations in the Lower Silurian strata south of the St. Lawrence. The strikes of the anticlinal beds are not precisely parallel, but converge towards the south-east; from which it results that the ridges or crowns of the folds have a slope in that direction.

ZOOPHYTA.

ZAPHRENTIS INCONDITA. (N. sp.)

"Undetermined species of *Zaphrentis*," Geol. Can., p. 393.

Pl. 1, figs, 1, 1*a*, 1*b*.

Description.—Corallum simple, turbinate and strongly curved at the base, becoming cylindrical above; nine or more inches in length and over two inches in diameter. From the acute base upwards it expands to a thickness of about fifteen lines in a length of two inches, and to twenty-four lines, in four inches; above which the body of the coral becomes more nearly cylindrical, or only very gradually increasing in diameter. Surface with numerous engirdling ridges of various sizes, the larger are from half a line to five lines in width, and are often angular on their crests. Upon these larger ridges and in the grooves between them are numerous smaller ridges or transvere striæ, generally two or three in a width of one line. The longitudinal, or septal striæ, are in general only obscurely seen, being obliterated by the transverse grooves; there are five or six of them in the width of three lines.

In the interior of the coral, the radiating septa reach the centre in the basal portion. But, above a diameter of one inch, there is a large space in the centre (as shown in fig. 1*a*) occupied by the transverse diaphragms alone, the septa not extending more than half an inch inward. There are two sets of them, the smaller projecting inward rarely to the depth of one line. There is one of the smaller between each two of the longer.

The transverse diaphragms are well developed. They are much undulated in the central portion (as shown in fig. 1*b*) and strongly curved downwards near the exterior. There appear to be ten or twelve of them in the length of one inch; but, owing to their undulations, there are sometimes places in which they are separated to the distance of two or three lines, while elsewhere they may be nearly in contact. The septal fossette has not been observed.

Varieties.—Occurring along with the above is a somewhat more slender form with, in a general way, the same external characters, but with the transverse diaphragms more regular and the septa extending inward

nearly to the centre. (Figs. 2, 2*a*, 2*b*.) One specimen has a diameter of eighteen lines and another sixteen lines.

A third specimen is only twelve lines in diameter, with the same characters as the last two.

The materials are not sufficient to enable us to decide positively whether they all belong to the same species or not. Should there be more than one species, the specific name above given ought to be retained for the larger form first above described.

Locality and Formation.—Indian Cove, Gaspé, in the Gaspé limestone, No. 8.

Collector.—R. Bell.

Zaphrentis rugatula. (N. sp.)

"Undetermined species of *Zaphrentis*," *Geol. Can.*, p. 391.

Pl. 1, fig. 3, 3*a*.

Description.—Corallum small, slender, straight, or only slightly curved, gradually increasing to a width of about one inch in a length of two or three inches. Surface with several engirdling undulations of growth, which are sometimes six or eight lines wide; when perfect, strongly marked with rounded longitudinal septal ridges, of which there are four or five in a width of two lines. These ridges are generally more or less undulated and irregular, giving to the surface a somewhat rugose aspect. This appearance is also in part due to the encircling striæ, which are very distinct, and sometimes exhibit a tendency to imbrication. There are five or six of these striæ in one line.

A longitudinal section through a larger individual (fig. 3*a*) shows, that in this species the cup is of great depth, in proportion to the size of the coral. All the dark-shaded space in the upper part of fig. 3*a* represents the cavity of the cup (filled with dark grey limestone) but not the whole of it, as it is evident that a portion of the margin is broken away. Close to the curved side of the figure, it will be observed that a portion of the dark shade extends downwards to a sharp point, close to the outer wall. This may indicate the place of the septal fossette. All below the dark shade, in the figure, is composed of reddish white crystalline limestone which, although finely polished, does not exhibit any certain evidence of transverse diaphragms. The septa are obscurely seen extending to the centre.

In another specimen, slit longitudinally and polished, the cup is seen to be fourteen lines in depth, although the length of the entire individual appears to have been not more than thirty lines. The septa, as seen

in a transverse section through the wall of the cup in this specimen, are alternately larger and smaller. There is an appearance of what may be tranverse diaphragms, but not sufficient to prove their actual presence.

Owing to the imperfection of the specimen, the number of the septa has not been ascertained, except in so far as they are indicated by the external longitudinal striæ. Assuming that each one of these indicates a single septum, then there would be about eighty septa, in the upper part of a specimen of the size of that represented by fig. 3. In the upper part there are four striæ in the width of two lines, but in the lower part there are five or six in the same space.

Some of the young specimens, those about an inch in length, in the collection, are quite straight, others curved. All are more or less strongly marked with undulations of growth.

Making allowance for parts broken away, the length of the specimen figured would be two and three-quarter inches and its width at the margin of the cup about twelve lines. Another specimen (nearly straight), which when perfect must have been two and a half inches in length, is ten lines in width at the margin. A third specimen fifteen lines in length is ten lines wide. This latter is evidently a young individual, and generally in this genus the proportions of the young differ from those of the adult.

Locality and Formation.—Cape Gaspé. Gaspé limestone, No. 1.

Collector.—Sir W. E. Logan.

Zaphrentis corticata. (N. sp.)

Pl. 1, figs. 4, 4*a*, 4*b*. (2, 2*a*, 2*b*.)?

Description.—Corallum two or three inches in height, straight, or only slightly curved, expanding to a width of eighteen lines at the height of two inches. Surface (in some specimens at least) exhibiting scarcely any trace of longitudinal striæ, but marked with numerous obscure engirdling wrinkles, from half a line to one line or more in width. In addition to these, there is a set of fine striæ, of which there appear to be four or five in the width of one line.

A fracture on one side of the specimen figured (fig. 4) shows that the cup is about nine lines in depth. In a polished transverse section of the same specimen at one inch from the base (just opposite the No. 4) forty-four principal septa are seen. Between each two of these there is a septum of a secondary series. Some of these latter appear to be obsolete, others project about a line inwards, while a few can be traced somewhat further. On the cast of the interior of the cup of a specimen which appears to have been about one inch in length, there are two

impressions of the principal septa in one line. On the surface of a small worn specimen, nine lines in length, there are five obscure septal striæ in the width of two lines. The principal septa on approaching the centre unite with each other laterally two or three at a time. The septa formed by these unions again unite, thus forming fascicles of from two to seven septa in each.

The specimens do not show clearly the depth of the cup, but it appears to be at least half the length of the coral. There are several species that resemble this closely in form, but I know of none with such surface characters. In species of this genus the surface is covered with longitudinal striæ, but in this the whole body of the coral, except a small portion at the base, is only transversely striated. This is owing to the thickness of the epitheca.

Locality and Formation.—Split Rock, Percé. Lower Devonian.
Collector.—Thomas Curry.

ZAPHRENTIS CINGULOSA. (N. sp.)

"Undetermined *Zaphrentis*," *Geol. Can.*, p. 439.

Pl. 1, fig. 5.

Description.—Corallum elongate, slender, cylindrical, more or less curved, with a number of deep concave constrictions from five to ten lines in width. Surface with strong rounded or sub-angular septal ridges, three or four in the width of two lines. These are crossed by fine transverse striæ, of which there are four or five in one line.

The specimen, a portion only of which is figured, is six inches in length and apparently tapers about two lines. When perfect it was probably ten or twelve inches in length. It is somewhat flattened by pressure, and the form of the part figured is restored. In the interior the septa are seen to reach the centre and there become much twisted and confused.

Only one specimen of this has been collected, but that is quite sufficient to show that it is distinct from any described form. In its surface characters it resembles *S. rugatula*, but the deep constrictions and great length are sufficient to prove it distinct. It is not certain that it is a *Zaphrentis*.

Locality and Formation.—Mount Joli, near Percé. Gaspé limestone No. 8.

Collector.—Sir W. E. Logan.

PHILLIPSASTREA AFFINIS. (N. sp.)

Description —Corallum in the form of lenticular masses or colonies, composed of corallites of from six to eight lines in diameter, closely compacted together so that the divisions between them are only obscurely distinguishable. The cups of these corallites are indicated by a number of circular pits in the upper surface of the corallum. They are nearly three lines in diameter and two lines in depth, their walls vertical, or nearly so, a small rugose elevation in the bottom. From the margin of each of the cups, about forty septal striæ radiate to the division lines between the corallites. The septal ridges between the striæ are angular and minutely serrated or denticulated along the sides, and apparently along the crests. The striæ are also crossed by minute transverse thread-like lines, about six in the width of one line. These characters cannot be seen unless in those places where the surface is perfectly preserved. In general the rays only appear as so many small ridges, somewhat rugose in aspect.

The corallites are five, six or seven sided, and the divisions between them are indicated either by small elevated rugose lines, or by the angle formed by the meeting of the septal striæ. The margins of the cups are sometimes slightly elevated above the general surface, but often are even therewith. The distance between the cups is usually five or six lines sometimes seven or eight lines.

This species is closely allied to *P. Verneuli* (Edwards and Haime)* but has somewhat longer corallites, and the margins of the cup not so much elevated.

Locality and Formation.—Indian Cove, Gaspé, in the Gaspé limestone, No. 8.

Collector.—R. Bell.

POLYZOA.

POLYPORA? PSYCHE. (N. sp.)

Description.—This species occurs in the form of large undulated expansions, with the longitudinal stems branched and converging in one direction. When perfect, it appears to have been infundibuliform, more or less conical at the base; but, above, with the margin, and at least the upper half, expanding and curving outwards. Large specimens appear to have formed a cup about five inches in height, and the same in width across the expanded margin.

* *Palypiers Fossiles des Terrains.—palœazoiqaes*, p. 447.

The longitudinal stems are, as seen on the outside, convex or semi-cylindrical, usually about-one third of a line in thickness, sometimes a little less or more, and about their own thickness distant from each other. They branch at distances varying from two to fifteen lines, most frequently at ten or twelves lines. These are usually about seven fenes trules in the length of three lines, with thin dissepiments between them. When perfect the stems appear to be covered, on the outside, by a smooth non-poriferous crust. When this is partially worn away, the stems are seen to be longitudinally marked, each with four or five deep striæ, separated by thin sharp edged ridges.

The poriferous side has not been seen. I am not sure that this is a true *Polypora*.

Locality and Formation.—Indian Cove, Gaspé Bay. Gaspé limestone No. 8.

Collector.—R. Bell.

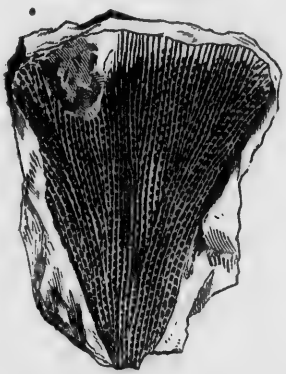

Fig. 1.

2a.

Fig. 2.

Fig. 1.—*Polypora Psyche.* Part of a large specimen.
2.—*Dictyonema splendens.* Part of a frond 2 *a*, portion of another specimen near the base, doubtfully referred to this species.

Dictyonema splendens. (N. sp.)

Fig. 2, 2*a*.

Description.—Frond four or five inches in length and width; longitudinal stems about one-third of a line wide, and about their own width distant from each other. The connecting bars, or dissepiments, are very slender and fragile. They seem to vary in their distances, from half a

line to three lines. It is probable that, when perfect, they are at a uniform distance of about half a line, and that when they are more remote some of the intermediate ones have not been preserved. The substance of the stipes is rough, black and shining, and apparently with some irregular longitudinal striæ.

No cells or serrations can be seen in any of the specimens examined. There are five or six longitudinal stipes in the width of two lines. In the specimen above, fig. 2*a*, however, they are more distant, and this may represent a distinct species.

Locality and Formation.—Between Cape Gaspé and Cape Rosier. Gaspé limestone No. 1.

Collector.—Sir W. E. Logan.

Ptilodictya tarda. (N. sp.)

Description.—This species is founded on a single specimen, about nine lines in length and two in width. At the basal extremity, for a length of two lines, the cells do not appear to be arranged in regular rows. At two lines from the base a bifurcation takes place at an angle of about 85°. Above this the cells are arranged in eight or nine longitudinal rows with a fine, thread-like, angular ridge between each two rows. At the length of about six lines another bifurcation takes place, the rows of cells being continued on both branches. The cells are nearly circular, each surrounded by an obscurely elevated margin. They are, on an average, one-twelfth of a line in diameter, and about their own width distant from each other. Between each two cells there is a small depressed space about the size of the cell itself.

The specimen is firmly imbedded in the rock, so that all its characters cannot be made out. It has, however, the compressed branching form, characteristic of the genus. The edges of the stem cannot be distinctly seen, but they appear to be acutely rounded. The thickness of the stem seems to be nearly one line.

Locality and Formation.—Grand Grève, Gaspé Bay. Gaspé limestone No. 8.

Collector.—R. Bell.

BRACHIOPODA.

Fig. 3. Fig. 4. Fig. 5.

Fig 3.—*Linguta Lucretia* Ventral valve. Fig. 4.—*Lingula Artinsis.* Fig. 5. *Crania bella.*

Lingula Lucretia. (N. sp.)

Fig. 3.

Description.—Shell small, sub-pentagonal or sub-ovate, apparently much compressed, or only very slightly convex; the beak of what seems to be the ventral valve is somewhat acute or minutely rounded. From the beak the sides diverge at an angle of 90°, or a little more, for about one-fourth or one-third the length of the shell; then they become sub-parallel and gently convex until near the anterior angles; the latter are obtusely rounded; the front margin is very slightly convex, or nearly straight for about one-third the width in the middle. The dorsal valve is of the same form as the ventral, but with the beak more obtuse.

Surface with a number of concentric undulations of growth, of which there are about ten or twelve upon a specimen four lines in length. Upon these, and in the hollows between them, there is a finer set, resembling sub-angular striæ, about twelve in the width of one line. These become more crowded together, on approaching the cardinal slope, in the rostral third of the shell. A few obscure longitudinal radiating lines can be seen on one of the specimens. The shell is thin, and of a brownish horn color with lighter concentric bands, not uniformly distributed. Length about four lines; width about three.

Locality and Formation.—Gaspé, Cape Bon Ami. Gaspé limestone No. 5. Passage beds.

Collector.—Sir W. E. Logan.

Lingula Artemis. (N. sp.)

Fig. 4.

Description.—Shell small, elongate, ovate; sides sub-parallel, gently convex; front margin uniformly rounded; apex sub-acute or acutely rounded; cardinal margins diverging at an angle of about 90°, for about one-third the length, gently convex; surface with fine concentric wrinkles or striæ; length, three lines; width, two lines.

This species is very closely allied to *L. Lucretia*, but is a narrower and proportionally more elongate form. Material may yet be found to connect the two, but for the present I shall keep them separate.

Locality and Formation.—Gaspé, Cape Bon Ami. Gaspé limestone No. 5. Passage beds.

Collector.—Sir W. E. Logan.

Crania bella. (N. sp.)

Fig. 5.

Description.—Of this species we have two valves lying close together on the same piece of stone, and thus appear to belong to the same individual. The one figured is sub-conical, the apex about in the centre and slightly incurved towards one side. This side of the shell has a concave slope from the apex to the margin, but the opposite side presents a gently convex descent. The other valve is gently convex, nearly flat, with the p ex close to one margin. Surface with between thirty and forty concentric striæ, with also some obscure undulations. Width about five lines.

Locality and Formation.—Gaspé, Cape Bon Ami. Gaspé limestone No. 5. Passage beds.

Collector.—Sir W. E. Logan.

Chonetes Melonica. (N. sp.)

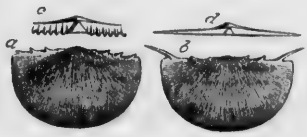

Fig. 6.

Fig. 6.—*Chonetes Melonica, a. b.*, two specimens showing remains of spines; *c.*, portion of the area of the ventral valve enlarged; *d* area natural size.

Description.—Shell of medium size, usually about ten or twelve lines wide; length between one half and two-thirds the width; hinge line equal to the greatest width of the shell; cardinal angles usually 90°, often a little less or more; all the front two-thirds of the shell uniformly rounded, sometimes with the front margin only very gently convex. Ventral valve usually strongly convex and often extremely gibbous, always more or less flattened towards the cardinal angles; area rather narrow, sometimes lying in the plane of the lateral margin, but more often, owing to the strong curvature of the upper part of the valve, partially inverted; foramen a little wider than high, closed by a convex deltidium; lower edge of the area in detached valves crenulated or serrated with small teeth, of which there are six or seven in one line; these teeth not visible when both valves are united; when the shell is well preserved and semi-translucent, faint, dark

lines can be seen beneath the surface of the area, as if it were penetrated by internal small tubes, passing from the teeth towards the cardinal edge, and inclining a little towards the beak; umbo moderate, but in the most ventricose specimens, the umbonal region is so exceedingly tumid, that it projects a little over the hinge line; beak not distinct from the cardinal edge. Dorsal valve with a curvature corresponding to that of the ventral, leaving but a thin space for the animal; area half the size of that of the opposite valve, and forming an obtuse angle therewith.

There are three or four spines on the cardinal edge of the ventral valve, rarely preserved. They incline outwards at an angle between 40° and 50°. I have seen no specimen with all the spines preserved, but it seems probable that those nearest the beak are the shortest.

Surface with fine, closely arranged, convex ribs, eight to ten, on an average in the width of one line, increasing both by bifurcation and interstitial addition, and crossed by exceedingly fine concentric striæ, of which there are between thirty and forty in one line. The ribs are slightly flexuous and of a very uniform size. In some specimens, the ventral valve exhibits an obscure mesial sinus extending from the beak to the front margin.

The form and dimensions of this species vary but little from the description above given. The cardinal angles are usually more acute and extended than they are in the two specimens figured; and in such instances the form closely resembles that of *C. acutiradiata*, Hall, Pal., N.Y., vol. 4, p. 20, fig. 5*b*. The spines also in these two species diverge at about the same angle, and, according to the descriptions, the surface characters are nearly the same. In the description of *C. acutiradiata*, no mention is made of the existence of teeth or crenulations on the area; it may be because the specimens were not in a condition to exhibit them if they really do exist. Should this character be yet discovered in the New York species, perhaps the two ought to be united. *C. hemispherica*, Hall, and *C. arcuata*, Hall, belong to the same group, but are considerably larger. I have compared *C. Melonica* with specimens of *C. striatella*, Dalman, from the Island of Gotland, Sweden; and also with *C. Nova-Scotica*, Hall, from Arisaig, Nova Scotia, and find it perfectly distinct from either.

The number of striæ on specimens of the average size is usually between seventy and eighty, but as many as 130 have been counted.

Locality and Formation.—This species occurs abundantly at Little Gaspé; in the Gaspé limestone, No. 8.

Collectors.—Sir W. E. Logan, R. Bell.

Chonetes Canadensis. (N. sp.)

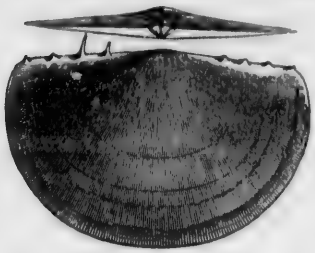

Fig. 7.

Fig. 7.—*Chonetes Canadensis.* A specimen of the long form. Specimens much broader and shorter proportionally occur. The upper figure shows the area, that of the ventral valve uppermost.

Description.—Shell semi-circular or semi-elliptical, the proportional length and width variable. Ventral valve gently convex, in general most elevated at about one-third the length from the beak; the cardinal angles flattened or slightly concave; umbo broadly depressed, convex; beak scarcely distinguishable from the cardinal edge. The area is rather large, being about a line high at the beak; nearly flat or very slightly concave, nearly smooth, no traces of crenulations; inclining backwards at an angle of about 45° with the plane of the lateral margin. The foramen is triangular, its width at the base nearly twice its height, extending nearly to the beak.

Dorsal valve gently concave, corresponding to the ventral valve, in its curvature, so as to leave only a thin space between them. The area is about one-third or one-half the size of that of the ventral valve, and forms nearly a right angle with the plane of the lateral margin.

The surface is covered with very fine, obscure radiating striæ, from ten to fifteen in the width of two lines. Some specimens, also, exhibit a number of concentric ridges or undulations of growth. Many show shallow, concave furrows from half a line to one line wide, which radiate from near the beak to the margin. These are most distinctly seen in specimens from which the shell is either wholly or partially removed. In such cases these furrows are either straight or slightly curved, the convex side of the curve being outwards, towards the sides. When the shell is a little worn fine closely arranged punctures may be seen between the striæ. When the shell is removed, the cast of the inner surface is sometimes quite rugose with punctures and obscure irregular tubercles. Often, however, the cast only exhibits the radiating striæ.

In some specimens, the cardinal edge of the ventral valve is quite sharp, and does not exhibit any indications of spines. In others there are four or five small tubercles or rudimentary spines, on the cardinal edge. When they can be seen they appear to be short, nearly erect or curving slightly inwards, as represented in the figure above. The following are the dimensions of several specimens in lines, the first number in each case being the width, 6–8½ ; 16–10 ; 20–12; 22–12; 24–14.

Small specimens of this species have nearly the proportion of *C. melonica* but are always nearly flat, while those of the latter are always more convex.

Locality and Formation.—This species occurs at Percé, Bay of Chaleurs. Lower Devonian.

Collector.—Sir W. E. Logan.

CHONETES DAWSONI. (*N. sp.*)

Fig. 8.

Fig. 8.—*Chonetes Dawsoni.* Ventral valve.

Description.—Shell semi-elliptical; width about one-third or one-fourth greater than the length; cardinal angles usually somewhat less than a right angle; sides, for about one-third or one-half the length below the hinge line, nearly straight, or gently convex; slightly converging towards each other, and then gradually and uniformly curving to the front margin which is broadly rounded.

Ventral valve gently concave, or nearly flat; the umbo slightly elevated; beak scarcely distinguishable from the cardinal edge. On the latter are from six to ten short spines on each side of the beak, sloping outwards at an angle of from 45° to 60°. The cast of the interior of this valve shows that there is a thin elevated ridge or septum, extending from the beak along the median line, about half the length of the shell. Two other obscure ridges diverge from the beak outwards, forming an angle of between 30° and 40° with the hinge line. The area has not been seen, but its impression shows that it is of moderate size, and inclined at an angle of about 45° to the plane of the lateral margin. Foramen triangular, the width apparently a little greater than the height.

The dorsal valve has not been seen.

The surface is covered with fine sub-angular radiating striæ which increase by fission and intercalation. Of these there are from seven to nine in the width of one line. There is also a set of minute concentric striæ, between thirty and forty in the width of one line.

The following are the dimensions of several specimens in lines, the first number indicating the width on the hinge line, and the second the length. 16–12, 12–8, 10–6, 11–7, 12–8, 14–10.

This species differs from all others of the genus, yet discovered in Canada, by having the ventral valve concave instead of convex.

Locality and Formation.—In the Gaspé sandstone at Gaspé, and in the limestone at Split Rock, Percé. Lower Devonian.

Collectors.—First discovered by Dr. J. W. Dawson, at Gaspé. Afterwards found by Thos. Curry at Percé. Lower Devonian.

Chonetes Antiopa. (N. sp)

Description.—Shell small, semi-elliptical; cardinal angles about 90°; sides nearly straight in the posterior third or half of the length, anterior angles uniformly rounded; front margin broadly or gently convex; width about one-fourth or one-half greater than the length. Ventral valve moderately and sometimes rather strongly convex, most elevated about the mid-length; somewhat compressed at the angles; umbo usually slightly elevated. Often the shell is more or less abruptly inflected about the mid-length, with a flattened or only gently convex slope to the front margin. Sometimes there is a shallow groove, which extends from the beak along the median line to the front. There are two spines on each side of the beak, slightly sloping outwards, nearly erect, sometimes gently curved, the convex side of the curve outwards. There may be a third spine at the cardinal angle, but it has not yet been observed.

The surface to the naked eye appears nearly smooth, but, when magnified, exhibits about fifteen rounded, sub-angular striæ in the width of one line.

Width four or five lines. Although a large number of specimens have been collected, none of them exhibit the area or the dorsal valve.

This species is about the size of *C. lineata*, Vanuxem, as figured in the Pal. N. Y., vol. 4, but is proportionally somewhat broader, not so convex, and has larger spines.

Locality and Formation.—In the limestone at Mount Jolli and in the Split Rock at Percé. Lower Devonian.

Collector.—Sir W. E. Logan.

Chonetes Laticosta. (Hall.)

Chonetes Laticosta (Hall). *Tenth N. Y. Rey. Reb. p.* 119, 1857 *Pal. N. Y.* vol. IV, p. 125, 1867.

Description.—Shell small, semi-elliptical; width about one-fourth greater than the length; cardinal angles about 90°, sometimes a little less; sides straight or gently concave for about one-third their length from the angles forwards; anterior half of the shell uniformly rounded. The ventral valve is usually strongly convex, most elevated at about the posterior third of the length, the umbo broad and rounded, the cardinal angles somewhat flattened or concave. The area is narrow, and appears to be nearly in the plane of the lateral margins. Surface with from eighteen to twenty-five strong, rounded or sub-angular radiating ribs, which are either single throughout the length of the shell, or, occasionally, sub-divided about the mid-length or a little in front thereof. The largest specimen in the collection is about six lines in width on the hinge line, and five lines in length. The others are about five lines wide. The dorsal valve has not been seen. No spines or indications thereof are visible.

This species differs scarcely at all from that of the Corniferous limestone, which Prof. Hall has described under the above name. The few specimens from the Corniferous that have been compared have the ribs somewhat smaller, but in no other respect is there any difference of importance. Prof. Hall intimates that *C. laticosta* is somewhat variable in its characters.

Locality and Formation.—At Little Gaspé, Grand Grève and Indian Cove, Gaspé. In the Gaspé limestone, No. 8.

Collectors.—Sir W. E. Logan and R. Bell.

Strophomena Galatea. (N. sp.)

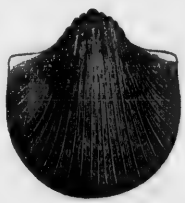

Fig. 9.

Fig. 9.—*Strophomena Galatea.* External view of a ventral valve, partly restored.

Description.—Shell of a medium size, semi-elliptical; cardinal angles about 90°; sides in the posterior half nearly straight and parallel; all of the exterior half uniformly rounded. Ventral valve exceedingly convex;

the cardinal angles compressed and slightly recurved; umbo very prominent, narrowly-rounded, projecting beyond the hinge line; beak small, incurved; area moderately developed, strongly concave, especially under the beak and for a short distance on each side thereof. Deltidium flat, triangular, smooth; its width at the base about equal to the height. When the surface of the area is perfect the dental striæ are only indistinctly or not at all visible, but where worn or exfoliated they come out to view. They are slightly oblique, the convergence being from the dorsal edge of the area inwards, or inclining towards the beak. The area in the lower, or dorsal, one-third, lies nearly in the plane of the lateral margin, but in the upper two-thirds it is strongly incurved, so as to become more nearly at a right angle to that plane.

Dorsal valve deeply concave; nearly in contact with the ventral valve at the cardinal angles, and for a space of about one-fourth the width, all round the sides and front; the distance between the two valves being the greatest a little above the middle. Area of the dorsal valve nearly as large as that of the ventral, parallel-sided, apparently not flat but slightly convex. It seems to form an obtuse angle with the area of the ventral valve.

Surface in one of the specimens covered with minute radiating striæ, about twenty in the width of one line. Along with these there are others about twice or thrice their size, and distant from each other from one-fourth to one half a line. No large striæ or ribs on the umbo. A second specimen has five or six large ribs, commencing at the beak and dying out before reaching the most prominent point of the umbo. The remainder of the surface covered with minute striæ, and larger lines, somewhat like those of the last specimen, but with concave, instead of flat spaces between them.

Only about a dozen imperfect specimens of this species have been collected, and they agree very nearly in form and dimensions with *S. demissa*, the type of Prof. Hall's genus *Strophodonta*. The exceedingly prominent umbo, and the minute striasion of the surface, are the only external differences between the two species. One of the specimens being partially silicified, I was enabled to free it from the limestone, with which it was filled by the application of an acid. Beneath the deltidium, under the beak, there is a septum, on each side of which is a deep pit for the reception of one of the branches of the divaricator process. The inner edge of the septum rests upon an arched plate, between which and the shell there is a third deep conical cavity, which extends nearly to the beak. There is no bilobed process. This structure is quite different from that of *S. demissa* in which, although there is a rudimentary septum, there is no

arched plate below it. Length, including the umbo, fourteen lines; excluding the umbo, twelve lines; width, thirteen lines.

Locality and Formation.—Indian Cove, Gaspé Bay. Gaspé limestone, No. 8.

Collector.—R. Bell.

STROPHOMENA MAGNIVENTRA. (Hall.)

Pl. 2, figs. 2, 2*a*.

STROPHODONTA MAGNIVENTRA. (Hall.) Tenth N. Y. Reg. Rep., p. 54, 1857. Pal., N. Y., vol. III., p. 411, pl. 92 and 95.

Description.—Shell rather above the medium size, semi-elliptical; cardinal angles about 90°; sides, in the posterior half, nearly straight or slightly concave; all of the anterior half uniformly rounded. Width on the hinge line from one to two inches and a half, usually about two inches. Length from three-fourths to five-eighths of the width.

Ventral valve usually strongly and uniformly convex, with the exception of the cardinal angles, which are more or less compressed. Some specimens are only slightly convex. Beak small, scarcely distinct from the edge of the area. On a side view the outline is strongly curved, most abruptly so from the beak over the umbo. (Fig. 2*a*.) The area is large, not flat, but more or less concave; when perfect, nearly smooth or with a few longitudinal striæ, (parallel to the hinge line). When the surface of the area is exfoliated or slightly worn, the vertical or dental striæ come into view. The edge of the area is denticulated throughout its whole length. Deltidium flat, smooth, triangular, its base about equal in length

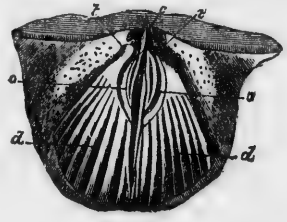

Fig. 10.

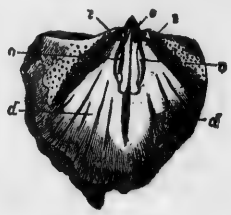

Fig. 11.

Fig. 10. Cast of the interior of the ventral valve of *S. magniventra* from the Oriskany sandstone. *c*. cast of the small umbonial cavity; *d,d*, casts of the divaricator muscular scars; *o, o*, casts of the occlusors; *t, t*, small tubercles which are the casts of the two small pits occupied by the extremities of the divaricator processes.

Fig. 11. Cast of the interior of the ventral valve from the Gaspé limestone. Letters, same as fig. 10.

to its height; the edge entire, thin and sharp in most of the specimens, but in others with apparently one, two or three small notches. The area, owing to the abrupt curvature of the valve at the beak, is inverted, or overhangs the hinge line, as shown in fig. 2*a*, (which represents, however, an extreme form.) Sometimes it is nearly in the plane of the lateral margin, but in all the specimens examined, in which it can be seen, it overhangs the hinge-line more or less.

Dorsal valve concave, the curvature conforming to that of the ventral valve. Area small, and at nearly a right angle to the ventral area.

In the interior of the ventral valve the muscular impressions occupy a large, ovate or flabelliform space, extending one-half or three-fourths the whole length of the shell. The divaricator scars are divided longitudinally into a variable number of lobes, usually ten or twelve, but specimens occur with as many as fifteen. In the one represented in pl. 2, fig. 2, there are five lobes distinctly marked out, but it can be seen that each of these is divided by an obscure ridge (not shown in the figure) into two, making ten in all. In others, from the same locality, there are ten or more lobes, well-defined, especially towards the front. The two divaricator scars are usually divided throughout their whole length by a medial septum which sometimes extends nearly to the beak (wood cuts No. 10, 11.) The impressions of the occlusors occupy a small ovate space, partly above and partly between the divaricators. The remainder of the interior of the shell is densely tuberculated. In most specimens it is somewhat smooth round the front, or marked with obscure radiating striæ.

Nearly all the space beneath the area is filled with solid shell, so that the hollow of the umbo is reduced to a small conical cavity, which sometimes reaches nearly to the beak, but often scarcely penetrates beyond the hinge line (wood cuts, No. 10, 11, *c*.) There is no rostral septum. The bilobed process on the inner surface of the deltidium is, in some specimens, obscurely represented by a small tubercle with a groove along the middle, as in *S. filitexta*. In others it appears to be absent altogether.

The interior of the dorsal valve is not shown in any of the specimens from Gaspé. The structure of the ventral valve, however, clearly proves that, when the two valves are in connection, the divaricator processes cannot project beneath the area, as they do in *S. demissa*. On each side of the mouth of the small conical cavity, beneath the deltidium, there is a shallow ovate pit excavated in the substance of the shell. The free extremities of the divaricator processes occupied these pits. The structure shows that the divaricator processes are short, and their extremities distant from each other about one line, in a specimen two inches in width.

This is well own in the specimens from which the wood cuts, figs. 12

and 13, were engraved. The two small tubercles *d*, *d*, are the casts of the two pits above mentioned.

Fig. 12.

Fig. 12. Part of ventral valve, shewing the deltidium, the dental striæ on the area, and the small pits *d*, *d*, of the divaricator processes.

The surface in most of the specimens is covered with small, nearly equal, rounded or sub-angular ribs, five to seven in the width of two lines. In others there are about three ribs in two lines, with concave spaces between equal to the ribs in size.

Locality and Formation.—Indian Cove, Gaspé Bay; Gaspé limestone No. 8. Also in the Oriskany sandstone in New York and in Ontario.

Collectors.—R. Bell, T. C. Weston.

STROPHLMENA INEQUIRADIATA.

Plate 2, figs. 4, 4*a*.

STROPHOMENA (STROPHODONTA) INEQUIRADIATA, (Hall.) Tenth N. Y. Reg. Rep., p. 113, 1857.

STROPHODONTA INEQUIRADIATA, (Hall.) Pal., N. Y., vol. 4, plates XI., XII., and XIII., 1867.

STROPHOMENA INÆQUISTRIATA, (Billings.) Canadian Journal, July, 1861. Geology of Canada, p. 367.

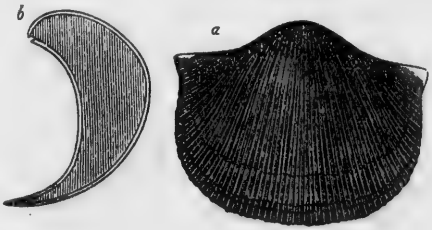

Fig. 13.

Fig. 13.—*Strophomena inequiradiata*; *a*, ventral valve; *b*, longitudinal section. In general the space between the two valves is not so great as in this latter figure.

Description.—Semi-circular, semi-oval, or sub-triangular; width on hinge-line varying from one to three inches; length from two-thirds to seven-eighths of the width; cardinal angles compressed, forming rounded or acute ears which are more or less extended. Ventral valve varying greatly in the amount and in the form of its convexity; usually with the

visceral disc depressed, convex, and the margin all round abruptly curved down for one-third or one-half the whole length of the shell; sometimes the shell uniformly arched from beak to front; the umbo often so greatly developed as to overhang the hinge-line and bring the area under the body of the shell; in other specimens the convexity of the umbo is continued along the middle to the front, producing a broad mesial carination; in many the front is greatly produced in a gradual slope from the anterior margin of the disc, and occasionally we find specimens with the front margin so much curved as to be to some extent inrolled under the shell; in all the umbo is more or less prominent, there being a somewhat flat or depressed sub-concave space of greater or less extent on each side extending to the cardinal angles. The dorsal valve is usually not so much curved as the ventral, thus leaving a comparatively large space for the animal.

Area of the ventral valve from one-fourth of a line to one line in width, flat at the base, concave above, obliquely striated, with the exception of a portion at the extremities varying from one-tenth to one-third the length between the foramen and the cardinal angles. The striæ at the sides of the deltidium reach nearly to the upper edge of the area, but they gradually become shorter outwards, leaving a smooth space above them. Deltidium flat, or nearly so, triangular; width at the base equal to a little less or a little greater than the height; a small notch in the middle of the lower edge, most probably for the passage of a pedicle; from this notch a narrow ridge extends upwards to the beak; cavity of the umbo divided into two compartments by a rather strong rostral septum. On each side of the septum there is sometimes a small projection, probably representing the bilobed process.

Area of dorsal valve about half-a-line wide, and not so variable in its dimensions as is that of the ventral. It seems to be not quite flat but slightly convex, and to form an angle of about 90° with the basal flat portion of the area of the ventral valve.

In the interior of the ventral valve the divaricator scars are large, sub-pyriform, and one-third the length of the whole shell. The occlusors are ovate, half the length of the divaricators, often with the surface covered with minute corrugated wrinkles like the scars of some species of *Productus*. The vascular impressions are well marked on some of the casts of the interior, but vary in the number of the branches, usually from three to five in the width of one line at the margin. In thin shelled individuals they are not seen at all. Interior of dorsal valve not observed.

Surface very variously striated. In some the striæ alternate in size, there being one set of fine sharply elevated lines distant from half a line

to one line from each other, the intervening spaces flat and with from three to seven finer striæ just visible to the naked eye; in others the intervening spaces are concave. In many the principal striæ become coarser and closer together, until the whole surface is covered with strong angular bifurcating ridges from one-fourth of a line to half a line in width. In very well preserved specimens of these latter, the coarse ridges are seen to be themselves ornamented with the fine longitudinal striæ. In all cases the whole surface, when perfectly preserved, is beautifully cancellated by minute crowded concentric striæ.

It would require a great many figures to represent all the forms of this species. The two given may be regarded as central and typical. The departures from these two consist principally in the contraction or extension of the cardinal angles; the greater projection of the front margin, which is sometimes narrowly instead of broadly rounded, Fig. 13 above, is from the Corniferous limestones, Ontario, and represents a form with strong radiating striæ. Fig. 4, pl. 2, is from the Gaspé limestones, the larger striæ distant with flat intervening spaces of fine, closely crowded, striæ.

The deltidium in one specimen is slightly convex on each side of the central ridge. In some a portion of the sides of the shell is bent nearly at a right angle towards the dorsal aspect.

In the publications of the Survey, this species has been heretofore referred to, *S. inæquistriata*, Conrad. Prof. Hall has described and figured it in the 4th vol. Pal., N. Y., under the name of *S. inequiradiata*. As that arrangement will most probably be followed, it is best for the sake of uniformity to adopt it. Although from Conrad's figure and description it is not certain that this is the form intended by him.

Locality and Formation.—Indian Cove, Gaspé Bay. No. 8. Also in the Oriskany sandstone and Corniferous limestone, Ontario. Occurs in N. Y. in Schoharie grit and Corniferous limestone.

Collectors.—Sir W. E. Logan, R. Bell.

STROPHOMENA VARISTRIATA. (Conrad).

Pl. 2, fig. 3.

STROPHOMENA VARISTRIATA. (Conrad.) Jour. Acad. Nat. Sci. Phi., vol. VIII, p. 255, plate 14, fig. 6.

STROPHODONTA VARISTRIATA. (Hall.) Pal., N. Y., vol. III.

Description.—The form of this species is exactly like that of *S. inequiradiata*, the only difference being that the shells are smaller. The surface characters are also the same. None of the specimens collected at Gaspé exceed an inch in width on the hinge line. Some of them have the

surface partially covered with small undulations, arranged in an obscurely concentric manner, as shown in fig. 8, pl. 2. Neither the area nor the internal characters are seen in any of our specimens.

Locality and Formation.—Between Cape Rosier and Cape Gaspé; in limestone No. 1, Lower Helderberg; occurs also in the Lower Helderberg series in New York.

Collectors.—Sir W. E. Logan, R. Bell.

Strophomena rhomboidalis. (Wilckins.)

This species has been found in Nos. 1, 5 and 8 of the Gaspé series.

Strophomena Irene. (N. sp.)

Plate 2, figs. 5, 5a.

Description.—Shell large, nearly flat; cardinal angles usually slightly projecting; sides in the posterior half either straight and sub-parallel or gently concave and converging towards the front; anterior half broadly rounded; front margin sometimes nearly straight in the middle. Width on the hinge line usually from two to three inches; length from one-sixth to one-third less than the width.

The ventral valve is very slightly and uniformly convex, most elevated about the middle or a little above, compressed towards the cardinal angles; umbo and beak small; area about two lines high at the beak in a specimen 2½ inches wide, inclining backwards at an angle of about 45° to the plane of the lateral margin. Dorsal valve gently concave, conforming in its curvature to that of the ventral valve; area half a line wide, forming nearly a right angle with the ventral area. The muscular impressions of the ventral valve are rather large, flabellate, extending from the beak nearly half the length of the shell. The divaricators (in the only specimens in which they have been seen) are divided into six or seven longitudinal lobes, not distinctly defined at their anterior margins. The occlusors occupy an elongate, narrow space, and seem to extend from near the beak to near the front of the divaricators. There is a slightly elevated mesial septum between the occlusors, one-half or two-thirds their length from the beak. Hinge line crenulated, apparently nearly out to the end. Deltidium and internal characters of the dorsal valve unknown.

Surface with coarse, flexuous, slightly elevated, rounded, radiating stri[illegible], which increase, both by bifurcation and intercalation, four or five in the width of two lines. When the surface of the shell is perfect, it exhibits a set of fine but very distinct concentric striæ, six or seven in the width of one line. When partially exfoliated these become obscure, or disappear altogether. The shell is not punctate.

This species belongs to the flat group which on this continent is typified by *S. perplana*, Conrad. It differs from all the ordinary forms of that group by its greater size and coarser radiating striæ. It resembles *S. magnifica*, Hall, and occurs in nearly the same geological horizon. It is, however, a good deal more flattened about the umbo of the ventral valve, and has much smaller muscular scars. In *S. magnifica* the scars are generally three-fifths the length of the shell; in *S. Irene* they are only a little more than two-fifths. The radiating striæ of *S. Irene* are of a very uniform size, as exhibited in about thirty individuals examined, always four or five in two lines, but, according to the figures given in the Pal., N. Y., vol. III, those of *S. magnifica* vary from three to ten or twelve in the same width; and, besides, the grooves between them are represented as distinctly punctate.

Locality and Formation.—Grand Grève, Gaspé Bay, No. 8.

Collectors.—Sir W. E. Logan, R. Bell.

Strophomena Blainvillei. (N. sp.)

Plate 2, figs. 1, 1*a*, 1*b*. Pl. 3, fig. 1.

Description.—Shell semi-elliptical, hinge line equal to a little less or a little greater than the width; sides in the posterior half usually gently concave, sometimes straight or gently convex; front broadly rounded, sometimes straitish in the middle; width from one-eighth to one-sixth greater than the length.

Ventral valve gently convex; greatest elevation about one-third the length from the beak; cardinal angles compressed; the umbo broadly obtuse; beak scarcely distinct from the cardinal edge; area flat, inclined at an angle of about 40° to the plane of the lateral margin, striated and with the edge denticulated its whole length; dorsal valve nearly flat, slightly concave; area very narrow; both valves usually with several concentric wrinkles or rugæ of growth.

Surface covered with fine, rounded or sub-angular radiating striæ, of a very uniform size; about twelve in the width of two lines. When slightly exfoliated the grooves between the elevated striæ are seen to be regularly pitted or punctated, from six to eight punctures in one line.

In the interior of the ventral valve the area occupied by the muscular impressions is of a sub-triangular shape, and extends from the beak about two-thirds of the length. The front of this area is generally broadly rounded; the two upper sides converging with a concave curve to the beak. The space on each side of the upper part of the area is strongly tuberculated, becoming gradually smooth towards the cardinal angles. A

thin mesial septum extends from the beak two-thirds the length of the shell. For the length of about a line from the beak the septum is much thickened, leaving in the cast of the interior a short, deep fissure, as shown in fig. 1. On each side of this fissure there are two tubercles, more or less elevated, which are the casts of the cavities in the shell, for the reception of the divaricator processes. The divaricator scars are divided into a number of lobes, usually five or six, but often more. The occlusors are rather small, and extend from the thickened part of the septum about one-third the length of the divaricators. All around the sides and front of the muscular area the casts of the interior are striated, the striæ often becom ing coarser as they recede from the margin.

The casts of the interior of the dorsal valve exhibit two ovate pits close to the beak (fig. 1*b*,) the impressions of the divaricator processes. From these two pits the impression of a short septum extends, ending in a point at about three lines from the beak. The occlusor scars are situated on each side of this septum, but their form is not exhibited in any of the specimens collected. The shell on each side of the scars is coarsely tuberculated, smooth along the hinge line and at the cardinal angles. The divaricator processes, as shown by their impressions, are short, erect, slightly sloping backwards, but diverging laterally.

None of the specimens are sufficiently perfect to exhibit all the details of the area. In some the casts show that there is a small triangular pit beneath the beak, as there is in *S. magnifica*.

Width on the hinge line from ten to sixteen lines. Length eight to fourteen lines. Specimens two inches wide are sometimes met with.

This species is, no doubt, closely allied to *S. perplana*, Conrad. It differs greatly from that species in the form of the muscular impressions, and it is only on account of this difference that I give it a name.

Locality and Formation.—Gaspé. In the lower part of the sandstone.

Collectors.—Sir W. E. Logan, Dr. J. W. Dawson, R. Bell.

Strophomena Tullia. (N. sp.)

Plate 2, figs. 6, 6*a*.

Description.—Shell large, nearly flat, semi-elliptical, cardinal angles sometimes slightly extended; sides in the posterior half straight or gently concave; anterior half broadly rounded; width on the hinge line from one-sixth to one-fifth greater than the length.

Ventral valve very slightly convex, most elevated in the middle or a little above, compressed towards the cardinal angles. Area about two lines high at the beak, inclining backwards at an angle of about 45° to the plane of the lateral margin.

In the interior of the ventral valve the muscular space is sub-triangular, rounded in front, with straight or gently concave sides, and extends about half the length of the shell. The width of this space, in a specimen thirty lines wide on the hinge line, is thirteen lines across the anterior angles. Its length the same (fig. 6*a*.) In a smaller specimen, sixteen lines wide on the hinge line, the length of the space is about seven lines, its width at the front five lines, (fig. 6.) The divaricators are divided into a number of longitudinal lobes, seven or eight in large individuals, fewer in the smaller, and sometimes very indistinct. The occlusors are narrow and half the length of the other two, very indistinct. The mesial septum sometimes extends the whole length of the muscular impressions, and becomes stronger on approaching the beak; in the small specimens it is very slight or absent altogether.

Surface with fine, rounded radiating striæ, ten or twelve in the width of two lines. These are crossed by very fine concentric striæ, which dis appear when the shell is slightly worn or exfoliated. In the cast of the inner surface of the ventral valve, all the space between the muscular impression and the cardinal angles is punctured. All around the sides and front margin the punctures are very small, and partially arranged in rows conforming to the radiating striæ.

The specimens as yet collected are not in a condition to show the area perfectly. It is, however, vertically striated and denticulated throughout nearly, if not entirely, the whole length. There seems to be a small triangular deltidium with a cavity beneath it.

Width of the largest specimen collected forty-two lines; length of the same three inches; dorsal valve unknown.

In *S. Blainvillei* the divaricators extend nearly two-thirds the length of the shell; in this species about half the length. It approaches *S. magnifica* in size, but the form and proportional length of the muscular impressions are different in the two species. It is closely related to *S. Beckii*, Hall, but attains a much larger size; is not concentrically wrinkled; has finer radiating striæ and a deltidium. *SIr ene* has only four or five radii in the width of two lines while this species has ten or twelve.

Locality and Formation.—Mount Joli and Split Rock, Percé. Lower Devonian.

Collectors.—Sir W. E. Logan, Thomas Curry.

STROPHOMENA PUNCTULIFERA, (Conrad).

Plate 3, fig. 2.

STROPHOMENA PUNCTULIFERA, (Conrad.) Ann. Rep. Pal., *N.* Y., 1838, p. 117.
STROPHOMENA PUNCTULIFERA, (Vanuxem.) Geol. Rep. 3rd Dist., N. Y., 1843, p. 122.
STROPHOMENA RUGLYPHA, (Conrad.) Ann. Rep. Pal., N. Y., 1841, p. 36.

STROPHOMENA PUNCTULIFERA, (Hall.) Geol. Rep., 4th Dist.
STROPHODONTA PUNCTULIFERA, (Hall.) Pal., N. Y., vol. III, p. 188, pl. 21, 23.

Description.—Shell semi-elliptical or sub-triangular; hinge-line usually a little greater in length than the width of the shell; sides in the upper half more or less concave, sometimes straight; anterior margin broadly rounded, occasionally sub-angular in the middle; length on the hinge-line from one to three inches, usually about two inches. Length from one-sixth to one-third less than the width.

Ventral valve concave, the umbo and a small space around it convex; sometimes a slightly elevated mesial fold runs from the umbo to the front margin; beak, small, incurved down to the cardinal edge, and often projecting a little over it; dorsal valve convex, with a portion in the middle of the upper half more or less concave. In some specimens a shallow mesial depression extends to the front. The valves are either slightly curved or nearly flat, or more or less abruptly geniculated at a variable distance from the hinge-line.

Area of ventral valve about two lines high, at the foramen, in a specimen of average size; slightly incurved beneath the beak, and for a short distance on each side. It varies in the amount of its inclination, sometimes forming nearly a right angle to the marginal plane, but usually sloping backwards, more or less. In a specimen twenty-four lines wide on the hinge-lines, the edge of the area is denticulated for the length of five lines on each side of the foramen; the remainder out to the cardinal angles, smooth and grooved, as in *S. euglypha* and others of this group. The foramen is closed by a convex deltidium, two lines wide at its base, and the area striated for about five lines on each side. The area of the dorsal valve is narrow, less than one line wide, and forms an angle of 90°, or somewhat more, with that of the ventral.

Externally the shell is covered with small angular ribs, from four to six in the width of two lines, increasing both by intercalation and bifurcation; often they become finer towards the margin than they are in the middle portion of the upper half. In some specimens, where the surface is perfect, there are no indications of either punctures or tubercles, on the ribs or in the grooves between; but, when the shell is exfoliated, the grooves are seen to be distinctly punctured or pitted. The inner surface of the shell is covered with small tubercles, which are larger and more dansely crowded together in the upper half, on each side of the muscular impressions, than they are elsewhere.

The muscular impressions are not well exhibited in any of our specimens.

The usual size of this species, is from twenty to twenty-eight lines wide on the hinge-line. It varies, however, both in the size and in the amount

of the convexity. One of the specimens examined is thirty-four lines wide on the hinge-line; twenty-five lines in length in a straight line from the beak to the front; thirty lines in length, following the curve of the dorsal valve, abruptly bent or geniculated at about fourteen lines from the beak, at an angle of about 120°, the most elevated point is twelve lines above the plane of the lateral margin. Another is twenty-six lines wide on the hinge, and, at about twelve lines from the beak, is abruptly bent at a right angle, and the extended forwards about twenty lines. The greatest elevation of this specimen is about twelve lines. From these highly convex forms to those nearly flat there is a gradual passage.

Variety.

The specimens, to which the above description relates, occur in Div. 1, of the Gaspé limestones. In the upper part of the series a variety occurs with fine thread-like radii, between every two of which there are from three to five much finer, apparently from twelve to sixteen in the width of two lines. This may constitute a distinct species, but the specimens as yet collected are not sufficiently perfect to decide that point.

I have compared the above with specimens of *S. euglypha*, both from Sweden and England, and consider them to be distinct species, although closely related.

Locality and Formation.—*S. punctulifera* occurs between Cape Rosier and Cape Gaspé, in the Gaspé limestones, Div. 1, where it appears to be common, but not well preserved. Also, rarely, in Div. 8. The "*Variety*" has only been found in Div. 8, at Indian Cove, Grand Grève, &c.

Collectors.—Sir W. E. Logan, R. Bell.

There are evidently several other species of *Strophomena* in the Gaspé Rocks, but the specimens as yet collected are not sufficiently perfect to admit of description. One of them appears to be *S. perplana*, Conrad.

Orthis Livia. (Billings.)

Orthis Livia, (Billings), Canadian Journal, vol 5, p. 267, May, 1860. Figs. 14, 15, 16. Geol. of Can., p. 369, fig 385 *a*, *b*, *c*.
(Hall) Pal. N. Y., vol. 4, p. 38, pl. 5.

Description.—Sub-orbicular or sub-quadrate; length about eight-ninths of the width; greatest width, usually a little in front of the middle; length of hinge line, one half to two-thirds the width of the shell; cardinal extremities rounded; sides in most specimens somewhat straight, often sufficiently curved to give a circular aspect to the shell; front angles obtusely

rounded; front margin in general broadly convex, sometimes with a small space in the middle nearly straight. Dorsal valve of a medium convexity, most elevated about the middle; the outline forming a uniform arch from the depressed beak to the front margin; the slope from the umbo towards the cardinal angles, gently concave; sometimes a barely perceptible mesial depression, commencing in a point at the beak, and becoming obsolete at one-half or two-thirds the length; area small, lying in the plane of the lateral margins; beak minute, forming a small triangular projection, rising scarcely one-fourth of a line above the edge of the area, the point not incurved over, but situated in the plane of the area. Ventral valve moderately convex, most elevated at between one-fourth and one-third the length from the beak, thence descending with a somewhat flat or gently convex slope, to the front and sides, and with a more sudden and somewhat concave slope to the hinge line and cardinal angles; the umbo small, prominent, neatly defined, terminating in a small rounded beak, which is incurved so as to overhang the edge of the area, either not at all or scarcely one-tenth of a line; area triangular, about one-fourth larger than that of the dorsal valve, forming an angle of about 105° with the plane of the lateral margin. The foramen not observed, but appears to be wider than high. On looking at the dorsal valve in a direction perpendicular to the plane of the shell, the small rounded umbo of the ventral valve can be seen rising about one-third of a line above the dorsal beak.

Fig. 14. 15. 16.

Fig. 14.—Ventral valve of *O. Livia.*
15.—Section through the beak of both valves.
16.—Dorsal view.

Surface with small sub-angular radiating ridges, of nearly a uniform size, from eight to ten in the width of three lines, increasing by bifurcation, strongly curved outwards to the upper part of the sides and cardinal angles, the intervening grooves sub-angular in the bottom, and equal to

the ridges in width. In very perfect specimens, very fine concentric sub-lamellar concentric striæ are visible, seven or eight to one line. In certain conditions of preservation also, the radiating ridges are seen to be sub-tubular, and exhibit numerous small oval or circular openings on their edges, each about the eighth or tenth of a line in width, and from one-fourth to two-thirds of a line distant from each other.

Width of largest specimen examined, eighteen lines; length, sixteen lines; thickness or depth of both valves, seven lines; height of area of ventral valve at the beak, one line; area of dorsal valve, four-fifths of a line; distance between the beaks, one line; length of hinge-line, ten lines. The most common size appears to be one inch in width. The beak of the ventral valve is incurved, so that it would touch a plane projected horizontally through the valve, at one-half the depth of the cavity.

In some specimens the ventral valve has a faint, barely perceptible mesial fold, extending from the umbo towards the front.

This species is allied to *O. Vanuxemi*, but is more coarsely striated. It may be identical with one of the other species described in the Report of the Regents of the New York University, but as it is impossible to identify it with any of the descriptions, I propose to name it as above.

Locality and Formation.—Indian Cove, Gaspé; No. 8. It occurs also in the Corniferous limestone in Ontario and New York.

Collectors.—Sir W. E. Logan, R. Bell and T. C. Weston.

Orthis Aurelia. (N. sp.)

Plate 3, fig. 3.

Description.—Of this species only two specimens have been collected, one of the ventral and the other of the dorsal valve; both imperfect. It appears to be semi-elliptical, width fifteen lines; length about twelve lines. Ventral valve rather strongly convex, most elevated at three lines from the beak; thence sloping gradually with a gently convex curve to the front, and concave on each side of the umbo outwards towards the cardinal angles. The umbo at three lines from the beak is elevated, four or five lines above the plane of the lateral margin; beak incurved. Although buried in the stone, judging from the height of the umbo, it would appear that this valve has a large triangular area, probably extending out to the angles. The dorsal valve is also convex, most prominent at about one-third the length from the beak, which is considerably depressed below the most elevated point of the shell.

Surface with about twenty-five strong rounded ribs, each about one-third of a line in thickness and somewhat less in height, distant from each

other about one line at the margin; the intervening spaces, concave or nearly flat.

This species closely resembles *O. pectinella*, Conrad, of the Trenton limestone, and seems to belong to a group not common in the Devonian.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Collector.—R. Bell.

Orthis Lucia. (N. sp.)

Plate 3, fig. 4, 4*a*.

Description.—Shell sub-circular; outline concave on each side of the beak; cardinal angles broadly rounded; sides gently convex; front either broadly rounded or with sometimes a portion in the middle slightly projecting. Ventral valve moderately convex, most prominent about the middle or a little above; cardinal margin and sides slightly compressed; umbo well developed, carinating the valve in the upper half; beak minute, incurved at a right angle over that of the dorsal valve, and apparently in contact with the same; area very small, scarcely visible. Dorsal valve very slightly convex; a barely perceptible mesial depression originating in a point at the beak and gradually widening to the front, where it flattens about one half the whole width of the valve. Beak minute, but distinctly visible when that of the opposite valve is removed; cardinal edge slightly sloping on each side of the beak; area not visible.

Surface with fine sub-angular striæ which bifurcate several times; those at the cardinal angles, and for some distance below, curving upwards as they approach the margin; four or five striæ in the width of one line.

Width of the largest specimen seen, eleven lines; length, about nine lines.

Closely allied to *O. planoconvexa*, Hall, Pal. N.Y., vol. 3, pl. 12, but differs in having no area as that species has.

Locality and Formation.—Indian Cove, Gaspé, in limestone No. 8.

Collector.—T. C. Weston.

Genus Rhynchonella. (Fischer, 1809.)

In the 4th vol. Pal. N.Y., Prof. Hall has pointed out, that in many of the fossil species that are usually referred to this genus, there is, in the dorsal valve, a mesial septum, that divides the cavity of the umbo into two compartments, and often supports a small sub-triangular chamber beneath the beak. In a number of empty shells of a species, from the Black River limestone, in our collection, this structure is well exhibited. In the recent species, *R. psittacea*, with which I have compared our fossil specimens, this septum does not exist. There is only a faintly elevated line

along the middle of the shell, which may represent it, but there is not the slightest indication of a division of the cavity of the umbo. The ventral valve of the fossil species does not differ from that of the recent, in any important character.

It is proposed, in the work above cited, to classify the fossil species (or at least such of them as have a rostral septum) as a sub-genus, *Stenocisma* a name suggested by Mr. Conrad in 1839, in his second Ann. Rep. on the Pal. N.Y. It remains, however, to be decided whether or not, *Rhynchonella loxia*, the type of Fischer's genus, possesses a mesial septum in the dorsal valve.

The difference between the species with the rostral septum and those without it seems to be the same as that between the genera *Athyris* and *Spiringera Athyris* has a septum and the beak of the ventral valve usually imperforate. *Spirigena* has no septum and the beak perforated. In both cases the septate genus precedes the non-septate in time.

Although I think it highly probable that a sub-division of the genus will be made, I shall provisionally refer our species to *Rhynchonella* for the present.

RHYNCHONELLA EXCELLENS. (N. sp.)

Fig. 17 Fig. 18.

Fig. 17—*Rhynchonella excellens.* dorsal view; 18, front view.

Description.—Sub-circular or obscurely sub-pentagonal; slope on each side of the beak concave; sides broadly and uniformly rounded; front margin, with about one-third the width in the middle, either straight or gently concave. Greatest width about the mid-length or a little in front thereof; width about one-sixth or one-fifth greater than the length. Ventral valve moderately convex; most elevated at about one-third the length from the beak; mesial sinus, at the front margin, about one-third the whole width of the shell; flat in the middle or uniformly concave, deeply indenting the edge of the dorsal valve, (fig. 18) but becoming nearly obsolete at about one-fourth the length from the margin, and disappearing entirely at about half the length of the value. Umbo

small; beak closely incurved down to the umbo of the dorsal valve. Dorsal valve somewhat more strongly convex than the ventral; the outline on a side view nearly parallel with the plane of the lateral margin for about two-thirds the length from the front, then abruptly curved down to the beak. Owing to the depth of the sinus the front margin, on a side view, is nearly squarely truncated for about half the depth of both valves. The mesial elevation is either uniformly convex or a little flattened in the middle, usually gently sloping but sometimes abruptly elevated at the sides of the margin. It becomes obsolete at one-half the length of the shell.

Surface with thirty to forty rounded or sub-angular ribs (counted at the margin.) Some of these on the mesial fold of the dorsal valve, and in the sinus of the ventral valve, are undivided throughout their whole length. On each side of the fold and sinus the ribs are bifurcated at various points between the beak and front margin.

In one specimen, from which the shell has been partially removed, the cast of the interior of the dorsal valve shews a mesial septum extending about one-third of the length from the beak.

Length of a specimen of average size, thirteen lines; width, sixteen lines; depth of both valves, nine lines.

This species seems to be rare, as only about a dozen specimens have been collected.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Collector.—R. Bell.

Rhynchonella Dryope. (N. sp.)

Plate 3 A. figs. 1, 1*a*, 1*b*, 1*c*.

Description.—Subcircular or subpentagonal; apical angle varying from about 95° in the smaller specimens to 130° in the larger. Slope on each side of the beak concave or nearly straight for two or three lines, then slightly convex; sides rounded; front margin, with a portion in the middle about equal to one-third the width, either straight or slightly concave. In the larger specimens the greatest width is about the mid-length; in the smaller somewhat nearer the front. Width of a large specimen, thirteen lines; length, eleven lines; depth of both valves near the front margin, eight lines. Ventral valve varying from slightly to moderately convex; a portion on each side of the mesial sinus flat or even slightly concave near the front margin; umbonarrow; beak incurved down to the umbo of the dorsal valve. The mesial depression is rather less than one-third of the whole

width, indenting the opposite valve, at the margin, to an extent equal to the depth of both valves or nearly so. From the margin it becomes gradually more shallow with an uniform curve until it becomes obsolete at about the mid-length of the shell, or a little above; a rib on each side slightly longer than the others extend, nearly to the beak, in some specimens. There are three ribs only in the depression, in all the specimens collected. The rib on each side presents a large flat, slightly convex or slightly concave face, sloping upwards, and more or less inclined outwards from the bottom of the depression.

The dorsal valve is rather strongly convex. On a side view (fig., b.) the front margin is nearly squarely truncated; the outline, from the most elevated point at the front, is sometimes nearly straight for one-third or one-half the length, but in general it is gently convex for that distance and then becomes more or less abruptly curved down to the beak of the ventral valve. The umbo is of moderate size, rounded, abruptly elevated from the beak in large specimens, sometimes with a very faint mesial depression for two or three lines. The mesial fold is strongly elevated at the front margin but dies out at the mid-length, or a little above.

Surface with strong sub-angular ribs; four on the mesial fold and three in the mesial depression. On each side of the mesial fold and depression there are usually five or six ribs in the smaller and medium-sized specimens, and seven, eight or nine in the larger. The most common number is six on each side.

The ribs are more strongly curved outwards towards their extremities than is represented in the above figures.

This species is closely allied to *R. Formosa*, Hall, Pal., N. Y., vol. 3, but attains a larger size, and is more coarsely ribbed.

Locality and Formation.—Grand Greve, Gaspé, Gaspé limestone, No. 8.

Collector.—R. Bell.

RHYNCHONELLA PLEIOPLEURA. (Conrad.)

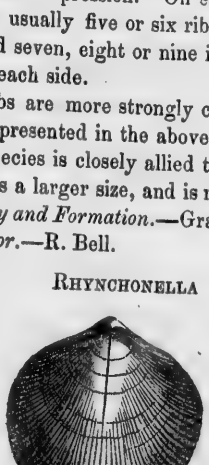

Fig. 19.

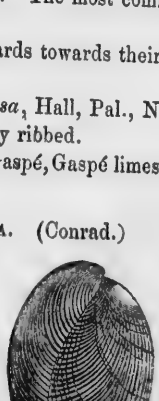

Fig. 20.

Fig. 19.—Dorsal view; 20, side view.

Description.—Shell sub-ovate, apical angle from 90° in the smaller specimens to 130° in the larger; greatest width about the mid-length, or a little in front thereof; slope on each side of the beak straight or slightly concave; sides rounded; front margin with a small portion in the middle about equal to one-fourth or one-third the greatest width of the shell, varying from narrowly rounded to straight. On each side of this median portion the margin is nearly straight and converging from near the mid-length towards the front at an angle of about 45° to the longitudinal median line of the shell. Ventral valve strongly and uniformly arched, from the beak to the median point of the front margin, most elevated about the mid-length, broadly and moderately convex in the posterior half or two-thirds; mesial sinus about one-third the whole width; the bottom either flat or slightly convex in the middle, strongly elevating the front margin of the dorsal valve; becoming obsolete at the mid-length of the shell or a little above. The shell on each side slopes down into the sinus with a convex curve. Beak closely incurved down to the umbo of the dorsal valve. Dorsal valve strongly convex, its greatest depth about the mid-length or a little in front thereof, posterior half broadly and uniformly convex; mesial fold strongly elevated at the front margin, flat or gently convex on the top, becoming obsolete at one-third or one-half the length, the sides (of the fold) sloping down to the body of the shell with a flat or sometimes gently convex slope.

On a side view, (fig 20.) the line of junction of the margins of the two valves forms a deep curve from near the beak to the front, convex towards the ventral valve. In the dorsal valve there is a median septum which extends from the beak nearly one-half the length of the shell.

Surface with numerous small sub-angular radiating ribs, usually three in the width of two lines at the margin in the front half, becoming finer in the upper half. In some specimens these are obscurely crenulated by concentric lines with occasional stronger rugæ of growth. The ribs on each side of the fold and sinus are generally bifurcated, the others (on the fold and sinus) are more often simple or undivided.

Length of a nearly perfect specimen, seventeen lines; width, fifteen lines; depth of both valves, eleven lines.

Locality and Formation.—Indian Cove, Gaspé, in the Gaspé limestone, No. 8.

Collector.—R. Bell.

EATONIA PECULIARIS. (Conrad.)

Plate 3 A, figs. 2, 2*a*, 2*b*, 2*c*.

ATRYPA PECULIARIS. Conrad, Ann. Rep. Pal., N. Y., 1841.

EATONIA PECULIARIS. Hall, Pal., N. Y., vol. 3, p. 244, pl. 38, figs. 21–26, and pl. 101, fig. 2, 1861.

Description.—Shell sub-ovate; apical angle from 90° to 100°; slope on each side of the beak either straight or very slightly concave for about one-third the length of the shell; sides in the anterior two-thirds or three-fourths nearly uniformly rounded; front irregularly truncated; greatest width a little below the mid-length,—equal to or somewhat greater than the length. Ventral valve, with a portion equal to about one-third the width in the upper half, and including the umbo, gently convex; the remainder, consisting of nearly the whole of the shell, slightly concave, and with a deep rounded mesial depression, which abruptly elevates the margin of the dorsal valve, and dies out near the middle of the shell. The beak is very small, incurved, not quite in contact with the dorsal valve. The edge of the shell, from the front margin upwards, is acutely angular, becoming slightly more obtuse and depressed on each side of the umbo. The mesial depression at the front margin is rather more than half the whole width. Near the beak a small portion of the edge of the shell is sharply inflected towards the dorsal valve. The dorsal valve is rather strongly convex, the middle third of the front, elevated into a short rounded mesial fold, sometimes with an obscure depression on each side. The umbo is moderately convex, obtusely rounded, the beak buried beneath that of the opposite valve.

Surface with very fine and obscure radiating striæ usually with one much larger than others along the middle of the mesial depression. These markings are so slightly developed, that, to the naked eye, the surface appears to be smooth.

Length of a large specimen, ten lines; width, the same; length of smaller specimen, seven lines; width, eight lines.

Our specimens differ from those that occur in the Oriskany sandstone of Ontario, and also from those figured in the Pal., N. Y., in having a wider and deeper mesial depression in the ventral valve. This valve, too, is upon the whole more concave than it is in the western specimens. It is much smoother than the Lower Helderberg *E. singularis*. In all other respects, even to the occurrence of the rib along the mesial depression, it is same. It might be called a variety, but I think not a distinct species.

Formation and Locality.—Indian Cove, Gaspé, No. 8. Also in the Oriskany sandstone in the Township of Oneida, Ontario. In New York it is said to occur in both the Lower Helderberg and in the Oriskany.

Collectors.—Sir W. E. Logan, R. Bell.

PENTAMERUS GALEATUS. (Dalman.)

This species occurs between Cape Gaspé and Cape Rosier in No. 1.

RENSSELÆRIA OVOIDES. (Eaton.)

Plate 3, figs. 7, 7*a*, 7*b*, 10, 10*a*.

RENSSELÆRIA OVOIDES, Hall; Pal., N.Y., vol. 3.

Description.—The usual form of the larger specimens of this species is elongate ovate; sides nearly straight or gently convex as shown in figs. 7, 7*a*. The smaller individuals (figs. 10, 10*a*.) are alway wider in proportion to the length and more pointed in front than the larger. In the proportions, there is a gradual passage from specimens in which the width is equal to the length, or even a little greater, to those which the length is twice the width. The ventral valve is the most convex of the two, usually obscurely rounded, angular along the middle, with a gently convex slope towards the sides; a portion of the margin bent at nearly a right angle towards the opposite valve. The outline on a side view is most elevated about the mid-length or a little above; abruptly curved down over the umbo to the beak, more gently and uniformly arched to the front margin. Umbo moderate, rising one or two lines above that of the opposite valve; beak closely incurved down to and in contact with the dorsal umbo. The depth of this valve is sometimes nearly equal to its width. Dorsal valve moderately convex, most elevated along the median line where it is rounded angular, with a gently convex, flat, or even slightly concave, slope towards the sides; a portion of the margin bent at nearly a right angle, as in the ventral valve. The umbo is only slightly prominent, the beak always concealed beneath the opposite beak.

In the young individuals, the angulation along the median line of both valves usually extends to the front margin; but, as the shell becomes larger, the anterior half or two-thirds becomes uniformly depressed, convex, and the angulation disappears.

Surface with fine radiating striæ, five to ten in the width of two lines. These striæ are most distinct at the front margin, and become obscure or die out altogether above the mid-length of the shell. Sometimes the upper one-third of the shell is quite smooth. The shell is also marked by a variable number of concentric wrinkles of growth, which give the outlines of the shell at all ages, and show how the same individual gradually changed from the broad to the narrow form as it increased in size. In general the specimens from the limestone are smoother than those from the sandstone.

Length of a full grown shell usually about two and a half inches; width, twelve to fifteen lines. Sometimes the depth of the two valves together is greater than the width. The shell is often more or less compressed laterally, and exhibits distortions, which are natural, or not the result of pressure.

Locality and Formation.—Indian Cove and Grand Greve, Gaspé. Very abundant in the Gaspé limestone, Div. 8, also in the Gaspé sandstone, and at Percé.

Collectors.—Sir W. E. Logan, Prof. J. W. Dawson and R. Bell.

LEPTOCŒLIA FLABELLITES. (Conrad.)

Plate 3, figs. 5, 5*a*, 5*b*, 6, 6*a*.

ATRYPA FLABELLITES. Conrad, Ann. Rep., 1841, p. 55.

LEPTOCŒLIA FLABELLITES. Hall, Pal. N.Y., vol. 3, p. 449, pl. 103, 106.

Description.—Ovate, sometimes nearly circular; apical angle varying from about 120° to 170°; cardinal edge either straight or gently convex, often slightly concave close to the beak; sides varying from gently to strongly rounded; front usually somewhat straight or slightly concave or convex in the middle third. Ventral valve moderately convex, most elevated a little above the mid-length. The mesial depression usually dies out at one-half or two-thirds the length, sometimes runs nearly to the beak, as in fig. 5. It has a single rib which extends from the beak to the middle of the front margin. There is usually a large rib, more prominent than any of the others, on each side of the mesial depression. From these large ribs, the shell descends with a flat, slightly concave, or slightly convex, slope to the margin. In some specimens the mesial depression is scarcely perceptible. Beak small, incurved down to the plane of the lateral margin, but not in contact with the dorsal umbo. Dorsal valve gently convex or nearly flat. In the upper half there is usually a slight mesial depression extending from the beak about half the length of the shell. Two of the ribs, one on each side of the mesial line, are larger than the others, and at the front are more or less elevated, forming an obscure mesial fold, which dies out about the mid-length of the shell. On each side of the fold the shell is often more or less convex, generally with a strong curve down to the margin around the front and part of the sides. The place of the umbo is nearly flat, with exception of the slight mesial depression above noticed.

The number of the ribs is slightly variable. In general the ventral valve has a single median rib, smaller than the others, and situated in the mesial depression. On each side, there are four or five well developed

ribs, with from one to three smaller, and obscure ones next the margin, in the upper half of the shell. The dorsal valve has two large median ribs, with six or seven on each side; those next the margin in the upper half small and obscure. When the shell is preserved the ribs are rounded, rarely sub-angular. They are crossed by obscure concentric lines, sometimes with one or more wrinkles of growth.

When the shell is completely absent, as is often the case in the sandstone, the ribs, as seen on the casts of the interior, are angular, while those of the dorsal valve do not often pass upwards beyond the mid-length of the shell. In the cast of the ventral valve the median rib becomes flattened or obsolete, in the upper half, where there is to be seen a small groove with a small semi-circular scar on each side (fig. 6*a*.) In the casts of the dorsal valve there is an irregular excavation, in the place of the beak and umbo, with a small medial groove extending down from it and two small punctures on each side. (Fig. 6).

In the description of this species, published in the Pal. N.Y. vol. 3, it is said that the beak of the ventral valve is incurved, "with a small round perforation in the extremity, which is completed on the lower side by two deltidial pieces; or, in the absence of these, the foramen is completed by the umbo of the dorsal valve. Our specimens are all imperfect at the beak, and do not exhibit the structure here alluded to. The dorsal valve is also said to be flat. None of the Canadian specimens have (strictly speaking) a flat dorsal valve. It is often flat or nearly so in the upper half, but always more or less convex in the front half, the shell being usually more strongly curved down around the front margin and along the lower half of the sides. In this respect it agrees with *L. Frimbriata*, Hall, (Op. cit., p. 450) which is said to have the dorsal valve flat or slightly convex, the front and lower lateral margins abruptly inflected.

Length of a large specimen, eight lines; width, four lines. The proportions vary within a small limit.

Under certain conditions of preservation, the shell has a whitish shining lustre, like that often presented by *Atrypa reticularis*.

Locality and Formtion.—Gaspé, in No. 8, and also in vast abundance in the lower part of the sandstones; it occurs also at Percé. Prof. Hall cites New York, Maryland, Virginia and Canada; Oriskany sandstone.

Collectors.—Sir W. E. Logan, Prof. J. W. Dawson, R. Bell.

Spirifera Gaspensis. (N. sp.)

Plate 3, figs. 8, 8a, 8b.

Spirifera Gaspensis, Geol. Can., p. 398.

Description.—Shell varying from semi-circular to transversely semi-elliptical, hinge-line much extended; often twice the length of the shell; in some specimens shorter, one-fourth or only one-fifth greater than the length. In the wide specimens the cardinal angles are acute, varying from 40° to 90°, sometimes a small portion of the sides, usually about one line in length, at right angles to the hinge; the remainder of the sides, around to the mesial fold or sinus, uniformly and gently rounded. In those with a short hinge, the sides, in the upper half of the shell, are straight or slightly concave, and at about 90° with the hinge line, the front half rounded. Ventral valve strongly convex, most elevated about the middle of the upper half, or a little above that point; cardinal angles more or less flattened; umbo prominent; beak small, strongly incurved; a well-defined mesial depression, concave or sub-angular in the bottom without ribs, extends from the beak to the front margin where it strongly elevates the edge of the dorsal valve, and, extending the whole width, slightly concave, one or two lines high at the beak. Foramen about three lines wide in a specimen of average size; deltidium convex, apparently not entirely closing the foramen. Dorsal valve with a strongly elevated mesial fold, without ribs; on each side of the fold moderately convex, compressed near the cardinal angles; umbo and beak curved down to the area, which is small, and apparently nearly in the plane of the margin, but sloping a little outwards. On a side view, the outline of this valve rises, with a more or less abruptly rounded curve, to about one-third the length of the valve and then becomes nearly parallel to the lateral margin, and continues to the front with a gently convex curve. The front margin, owing to the great elevation of the mesial fold, is nearly squarely truncated, as seen in the side view.

Surface with from twelve to eighteen simple undivided ribs, on each side of the fold and sinus. These are often crossed by concentric zig-zag imbricating lines of growth. In the casts, the ribs vary from acutely angular to rounded angular. When the shell is preserved the ribs are obtusely angular.

In the casts of the interior (the condition in which the specimens are usually found in the sandstone) the mesial fold of the dorsal valve often exhibits a fine groove along the middle, as if impressed by a thin septum. This is not visible in all the specimens, especially those that are slightly

worn. On each side of the umbo of the ventral valve there is (in the casts) a short deep fissure from one to three lines in length.

Width of a large specimen on the hinge line, twenty-four lines; average width, eighteen lines. The ribs vary slightly in size in different specimens. There are usually five or six in the width of six lines, next to the fold or sinus. The mesial fold and sinus are from four to six lines wide at the front margin. The fold is often elevated six lines at the front.

Locality and Formation.—Gaspé sandstone, Gaspé Bay; in great abundance; more rarely at Split Rock, Percé.

Collectors.—Sir W. E. Logan, Dr. J. W. Dawson, R. Bell.

Spirifera Superba. (N. sp.)

Plate 3 *A*, figs. 3, 3*a*, 3*b*.

Description.—Shell above the medium size; with an extremely and angularly elevated dorsal valve, and a very large mesial sinus in the ventral valve. Hinge-line equal to, or a little less than the greatest width of the shell. Sides rounded in the large specimens; straight in the upper half and rounded below in the smaller. Front margin broadly rounded, or with a portion in the middle either sinuated or projecting,—the outline varying according to the position in which the specimen is viewed. Width from 2 to 2½ inches. Length varying from five-eighths to six-eighths of the length. Depth of both valves sometimes greater than the length. Ventral valve moderately convex, most prominent a little below the hinge-line; on each side of the umbo abruptly curved down to the edge of the area; cardinal angles inflected towards the dorsal valve; umbo of moderate size; beak small, short, closely incurved over the edge of the area, nearly in contact with the opposite valve; area about two lines high beneath the beak, concave, forming, in a general way, an angle of about 45° to the longitudinal plane of the shell; foramen rather broad, its sides meeting at an angle of about 90° beneath the beak; deltidium obtusely angular along the middle, sloping to the sides, only about half closing the foramen, there being a triangular opening between it and the hinge-line; mesial sinus inconspicuous on the umbo, but in proceeding towards the front, rapidly enlarges and greatly elevates the margin of the dorsal valve. It is concave in the bottom, and its sides slope upwards and outwards, gently curving over to the most prominent part of the surface on each side. Its greatest width is about two-thirds the whole width of the shell. The curve of the shell along the bottom of the sinus is gentle and gradual from the front until near the umbo.

Dorsal valve strongly elevated, narrowly rounded or subangular along the median line, thence descending with a somewhat concave slope to the sides. (Fig. 3*a*). The mesial fold is very obscurely indicated in large specimens. Along the crest of the median line there is a single large rounded rib, about twice the size of the others; below this, on each side, there are four ribs which may be said to belong to the fold, as there is between the fourth rib and the fifth a slight depression which may be seen, in some specimens, running from the front margin upwards; from this the slope is at first nearly flat or very slightly convex, becoming concave on approaching the cardinal angles, and more convex towards the margin in the anterior half; the umbo is obscurely indicated; the beak scarcely distinct from the cardinal edge: the area is about one line high at the beak, and slightly overhangs the hinge-line.

This shell is so abruptly truncated, that when placed on the front margin it stands upright. On a side view, in this position the suture between the two valves is seen to be strongly curved towards the ventral valve; the median line of the dorsal valve rises almost vertically, at a right angle, to the truncated front margin. The lower two-thirds is gently convex. In the upper third, it is abruptly curved down to the beak, which it reaches almost at a right angle to the vertical plane. (Fig. 3*b*). The size of the ribs is somewhat variable. In specimens two inches wide there are from three to four ribs in the width of three lines, at the front margin. Along the median line of the dorsal valve, forming the crest of the mesial fold, there is a single large rounded rib, two lines wide; in the bottom of the mesial sinus of the ventral valve there is also a large rib, but concave; the cardinal angles and the umbones of the two valves are nearly smooth; the ribs vary from moderately convex to nearly flat; those on each side of the mesial fold appear to be bifurcated near the beak, all the others undivided. The surface is also more or less marked by concentric wrinkles of growth, and there appears also to be a set of fine concentric striæ.

This species differs from *S. arenosa*, in having a much smaller area, a much deeper mesial sinus in the ventral valve, a larger fold on the dorsal, and a large undivided rib along the mesial line of both valves.

Small specimens, about an inch wide, have the upper half of the sides straight and often at right angles to the hinge line.

Locality and Formation.—Indian Cove, Gaspé limestone, No. 8.

Collectors.—Sir W. E. Logan, R. Pell.

SPIRIFERA RARICOSTA. (Conrad.)

Plate 3 *A*. figs. 5. 5*a*. 5*b*.

DELTHYRIS RARICOSTA, (Conrad.) Jour. Acad. Nat. Sci. Phil. vol. VIII p. 262, pl. 14. fig. 18, 1842.

DELTHYRIS UNDULATUS, (Vanuxem.) Geology of the Third District of the State of New York, p. 132, fig. 3, 1842.

SPIRIFERA RARICOSTA. (Billings.) Canadian Journal, vol. 6 p. 259 1861.

Description.—Sub-quadrate, sub-semicircular or ovate; hinge-line equal to the greatest width of the shell, a little greater or less; dorsal valve usually with five, and ventral valve with six, large rounded or sub-angular ribs; length of full-grown individuals about one inch; width equal to or a little greater than the length.

The dorsal valve is most convex in the middle and more or less flattened or concave towards the cardinal angles; the area narrow, sub-linear; the beak small pointed and, together with the area, strongly incurved over the hinge-line; the middle rib, corresponding to the mesial fold of an ordinary *Spirifera*, is usually very prominent, rounded or sometimes a little flattened on the top; its width at the front margin, in a specimen fourteen lines wide, is about five lines, and it is well defined and prominent all the way to the point of the beak; the ribs next to it on each side also reach the beak, but the two outer ribs become obsolete on approaching the hinge-line. The ventral valve is most gibbous in the upper half; the umbo rather small but prominent, and the cardinal angles not flattened; the area is somewhat variable in its dimensions; and cannot be seen when the shell has been compressed; in large perfect specimens it is two lines high at the beak and half a line at the cardinal angles, and slopes outward at an angle of about 100° at its base, but is more or less arched towards the dorsal valve, so that its general direction is more nearly in the plane of the lateral margins; the beak is small pointed, always incurved over the area; the mesial furrows and four of the ribs extend quite to the point of the beak; the mesial furrow in all the specimens that I have seen is broadly rounded, while the lateral furrows are somewhat angular in the bottom.

The surface is usually covered with small lamellose, somewhat rough ridges of growth; and in the more perfect specimens with fine imbricating concentric lines, of which there are from four to eight in one line; all of these are undulated upwards in crossing the ribs.

In general the area of the ventral valve is only moderately inclined outwards, but it sometimes, in its basal portion, is nearly at a right angle to the plane of the lateral margins. It is always more or less concave.

There are sometimes one or two obscurely developed ribs at the cardinal angles, so that the number of the ribs may be, for the dorsal valve, five, seven or nine; and for the ventral valve, six, eight or ten. Specimens occur with the mesial fold greatly elevated and produced forwards, forming a strong projection in the middle of the front margin.

Some of the exfoliated specimens exhibit from one to three large rounded knobby projections on some or all of the ribs.

Locality and Formation.—Grand Grevé, Gaspé; Gaspe limestone, No 8. It occurs in the Corniferous in Ontario, and in the same formation in the State of New York.

Collector.—R. Bell.

Spirifera cycloptera. (Hall.)

Plate 3 A, figs. 4, 4*a*, 4*b*, 4*c*.

Spirifer cycloptenus. (Hall.) Pal. N.Y., vol. 3, p. 199, pl. xxv, fig. 1,*a*—z.

Description.—Sub-semicircular; varying from moderately to rathe strongly convex; in a view of the hinge-line the outline of the two valves is lenticular; cardinal angles either rounded, rectangular or slightly acute; outline of the front half broadly rounded, a portion in the middle slightly concave or projecting. Ventral valve usually the most convex, greatest depth a little above the mid-length; compressed at the cardinal angles; umbo and beak small, the latter incurved, sometimes nearly in contact with the dorsal umbo; area small, about one line high in a specimen sixteen lines wide, concave, not extending quite to the cardinal angles. The mesial sinus is concave, its width at the front margin equal to about one-fourth of the whole width of the shell; it extends to the beak.

Dorsal valve generally not so convex as the ventral; mesial fold rounded; area small, in the plane of the lateral margin; umbo on a side view a little elevated above the edge of the area; beak scarcely distinct, closely incurved.

A large specimen, sixteen lines wide, has eight moderately convex rounded ribs on each side of the mesial fold and sinus; two of these at the cardinal angles are obscurely developed. Smaller individuals have only five or six ribs. The surface has, to the naked eye, usually a smoothish aspect, but when perfect is seen to be covered with concentric sub-lamellose striæ, which are crossed by very fine longitudinal striæ, giving a minutely fimbriated appearance.

The size varies from five to eighteen lines in width.

Locality and Formation.—Grand Grève, and Indian Cove, Gaspé No. 8. Also at the Split rock, Percé. In the State of New York, it occurs in the shaly limestone of the Lower Helderberg Group.

Collector.—R. Bell, T. Curry.

Cyrtina affinis. (N. sp.)

Plate 3 A figs. 6, 6*a*, 6*b*.

Description.—Ventral valve sub-pyramidal, the apex sometimes more or less twisted; mesial furrow angular at the apex, becoming sub-angular below and sometimes rounded at the basal margin. On each side of the mesial furrow there are five or six ribs, those next the mesial furrow the largest, the others becoming smaller and more obscure outwards. On most of the specimens there are several concentric striæ. The area is large and concave, its height equal to about half the width of the shell at the hinge-line. The deltidium is convex, at the base equal to one-fifth the width of the shell; an aperture near the apex in some, if not in all, the specimens. This aperture is sometimes not visible. The area is transverse ly striated.

Dorsal valve gently convex, a strong rounded median rib, with five or six on each side. This valve is nearly semicircular, its length being nearly half its width on the hinge-line.

In 1863, I discovered the spiral coils in this species, and gave an account of them in the Canadian Naturalist, vol. 8, p. 37. I then supposed it to be *C. Dalmani*, Hall. As the specimen has since been damaged, so that the structure of the coils cannot be seen, I shall here copy what was published at the time:

"Mr. Davidson in his Monagraph on the British Carboniferous Brachiopoda, p. 68 points out, that no spiral coils had been noticed in the genus *Cyrtina* by any author. By working at some silicified specimens with acid, I have been so fortunate as to discover these organs in two species. Their position is the same as in *Spirifera*, but the first two coils are (at least in one of the species, C. Dalmani, Hall) connected a little in front of the mid-length by an apparatus somewhat like that of *Spirigera*, but not so complicated. A very slender process springs upwards towards the ventral valve, from each coil, and, at the height of about one line, curves forwards. The two then unite and form a single band, which extends forwards to about the front of the coil, and there ends in an obtuse point."

The dorsal valve of this species has two small projections between the dental sockets, somewhat like the divaricator processes of a *Strophomena*.

Width of largest specimen seen, one inch; height of area, six lines.

Locality and Formation.—Grand Grève, Gaspé. No. 8.

Collector.—R. Bell.

LAMELLIBRANCHIATA.

Sanguinolites Tethys. (N. sp.)

Plate 4, figs. 5, 5*a*.

Description.—Elongate; dorsal and ventral margins sub-parallel; anterior extremity rounded, most extended at about one-third the height; posterior extremity obliquely truncated; beaks at about one seventh the length of the shell from the anterior ends, closely appressed; a strong obtusely rounded convexity extends from the beaks to the ventral posterior angle. Length, three and one-half inches; height, about fifteen lines; depth of both valves, nine lines.

Only one specimen, an internal cast, of this species has been collected. The ventral margin is imperfect, but it appears to have been gently convex, with a slight sinuation just anterior to the mid-length. The hinge-line is straight and two-thirds the length of the shell, slightly elevated posteriorly. The slope of the posterior margin occupies about one-third of the whole length. The posterior ventral angle, narrowly rounded or sub-acute. Above the diagonal convexity, which extends from the beak to the lower posterior angle, the sides are compressed or slightly concave. Below it they are gently convex, with a broad shallow concavity from the beak to the ventral margin.

The characters of the hinge line cannot be made out from this specimen. It seems, however, to have had an external ligament. Just below the dorsal edge and parallel to it, there is an obscure groove in the cast, indicating a tooth or a ridge on the shell. Surface unknown.

Locality and Formation.—Grand Grève, Gaspé. No. 8.

Collector.—R. Bell.

Goniophora mediocris. (N. sp.)

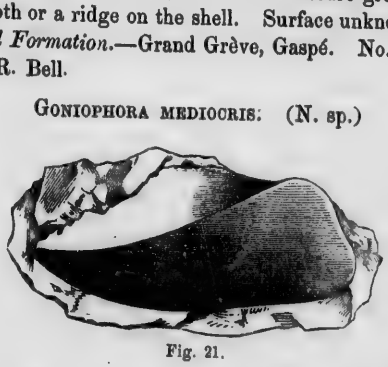

Fig. 21.

Fig. 21.—Goniophora mediocris. Internal cast of a left valve.

Description.—Length of the cast of the interior about two inches; greatest height, (near the mid-length) one inch; base gently convex with

an obscure sinus a little in front of the middle; hinge slightly ascending backwards, to a point just behind the mid-length. From this point the posterior margin descends, with a straight or gently concave slope, to the posterior angle, which is situated at about one-third the whole height of the shell. Beaks small, closely incurved, almost in contact with each other, at about one-half the height of the shell; below them the anterior extremity projects two or three lines. From the beak a strong sigmoid angulation extends to the posterior angle. The surface above this is gently concave, and below gently convex. A broad, shallow, barely perceptible depression extends from the beak to the ventral margin, which it reaches just behind the middle. Greatest depth of the valve a little in front of the middle. Depth of both valves at this point (in a specimen about two inches long) one inch.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Collector.—R. Bell.

Grammysia Canadensis.

Plate 4, fig. 3.

Description.—Transversely sub-ovate; posterior extremity obliquely truncated; dorsal and ventral margins sub-parallel, slightly converging posteriorly; umbones moderate, rounded, occupying about one-third the height; most projecting point of the anterior extremity situated at about half the height of the shell. The upper posterior angle is obtusely rounded, about one-fifth the length in front of the lower angle, which latter is narrowly rounded or obtusely angular, and just above the line of the ventral margin. The posterior edge, between these two angles, is gently convex, somewhat straight in the middle. Dorsal margin, slightly arched, almost straight, gently curving over the posterior angle, more abruptly rounded at the umbones. Ventral margin, nearly straight or slightly concave in the posterior two-thirds; the remainder, at first gently, and then somewhat abruptly rounded up to the anterior angle, between which and the umbo there is a concave notch. Length, about twice the height; the greatest height a little in front of the mid-length. The valves are moderately convex, obliquely flattened from the umbones to the posterior half of the ventral margin. A rounded ridge commences at the beaks, and runs obliquely downwards and backwards towards the middle of the ventral margin, before reaching which it becomes obsolete. On each side of this ridge there is a narrow sulcus. A moderately strong rounded angulation extends from the beak, just below

the dorsal margin, to the lower posterior angle. The beaks appear to be small and closely incurved.

Surface covered with concentric ridges from one half a line to two lines wide each. On the umbones, and on the anterior half of the shell, these are rounded, but towards the posterior extremity, they become flattened and sub-lamellose at their lower edges.

Length of the largest specimen collected, thirty-three lines; height, nineteen lines; depth of a single valve, six lines.

Locality and Formation —Gaspé; lower part of the Gaspé sandstone.

Collectors.— Sir W. E. Logan, R. Bell.

Modiomorpha inornata. (N. sp.)

Plate 4, fig. 4.

Description.—Transversely sub-elliptical; length, a little less than twice the height. Dorsal margin, from the umbones to about one-fourth the length from the posterior extremity, nearly straight, very slightly convex. Ventral margin gently convex. Posterior extremity obliquely and obscurely truncated, with a gently convex slope, in the upper half, uniformly rounded below, most projecting point at about one-third the height. Anterior extremity most prominent about the mid-height, rounded in the lower half; in the upper, apparently, obliquely truncated, with a gently convex or nearly straight outline. The umbones are obscurely developed, obtuse, about one sixth the length from the anterior extremity. Surface with concentric striæ, the stronger of which are one or two lines distant from each other; the finer ones apparently four or five in the width of one line.

Length, thirty-four lines; height, nineteen lines; depth of a single valve, about six lines.

The specimen is a cast in sandstone, and apparently slightly flattened by pressure.

Locality and Formation.—York River, Gaspé; Devonian.

Collector.—R. Bell.

Mytilarca Canadensis. (N. sp.)

Pl. 4, fig. 2, 2*a*.

Description.—Outline of a cast of the interior, on a side view, semi-ovate; the anterior margin concave, for a short distance below the beaks, and then nearly straight to the lower anterior distance, which is obtusely rounded; dorsal margin (in upper part) forming an angle of about 60° with the anterior, descending from the beaks with a nearly straight slope

for about one-third the length, and gradually curving into the posterior side; the latter broadly and uniformly rounded to the base. The anterior side of the cast is nearly flat, gently concave, regularly cordiform in outline. (Fig. 2*a*.) Beaks small, strongly incurved, almost in contact. There appears to be a short straight hinge between the beaks, about an inch in length, forming an angle of about 50° or 60° with the general plane of the flat anterior side. The edge of the anterior side, from the beak along the umbo, is acutely rounded, but gradually becomes more and more obtuse, as it approaches the base.

The cast exhibits a few concentric grooves, indicating, perhaps, lamellose rings of growth on the surface of the shell.

Height, from beak to base, three inches; width at about half the height twenty lines; depth of both valves, measured across the flat anterior side, (fig. 2*a*) twenty-six lines.

Locality and Formation.—Gaspé: Gaspé limestone, No. 8.

Collector.—R. Bell.

MYTILARCA NITIDA. (N. sp.)

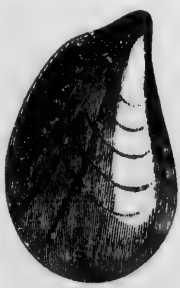

Fig. 22.

Fig. 23.

Fig. 22.—*Mytilarca nitida.* Internal cast of left valve.

Fig. 23.— " " " View of the anterior side.

Description.—Cast of the interior ovate; anterior side gently concave in the upper two-thirds, slightly convex below; posterior side broadly and gently convex, a small portion next the beak, (indicating the hinge-line) straight. Base nearly uniformly rounded. Umbones moderately prominent, obscurely carinate or narrowly rounded. Beaks small, closely incurved, almost in contact, slightly turned forwards. Between the beaks there is a short straight hinge-line, which forms an angle of a little less than 90° to the anterior side. The outline of the anterior side

is elongate, ovate; rounded at the apex; the sides most prominent a little above the middle; thence narrowing to a point at the base. The posterior side of the cast has a compressed margin, about two lines wide at the end of the hinge-line, gradually becoming obsolete towards the base. On the anterior side, beneath the beaks, there is a concave space which dies out before reaching the middle. About one line below the beaks there is an obscure projection, indicating the anterior extremity of the hinge-line.

The surface shows a few obscure concentric lines and faint radiating grooves. These latter, although apparent on the cast, may not occur on the surface of the perfect shell.

This species differs from *M. Canadensis* in having only a small portion beneath the beaks depressed, while that one has nearly the whole of the anterior side concave. Height of the largest specimen collected, twenty-one lines; width a little below the middle, thirteen lines; depth of both valves, twelve lines; length of hinge-line, six lines.

Locality and Formation.—Indian Cove; Gaspé limestone, No. 8.

Collector.—R. Bell.

Leptodomus Canadensis. (N. sp.)

Plate 5, fig. 1.

Description.—Transversely elongate, oblong. Dorsal margin, as seen in the cast of the interior, nearly straight, gently concave, slightly the most elevated at the umbones. Ventral margin gently convex; a small portion at the anterior third concave; the posterior third ascending with a moderately convex curve. Anterior extremity slightly sinuated at about the mid-height; below the sinus, a little projecting and narrowly rounded; nearly vertical above; rounded over the umbones. Posterior extremity with the most projecting point just above the mid-height; gently rounded below; obliquely truncated above.

The shell is rather strongly convex, most prominent about the middle or a little in front thereof. The umbones are large, beaks incurved. From the anterior third of the ventral margin an obscure shallow depression in the surface ascends obliquely upwards and forwards, dying out on the umbo, before reaching the beak. The umbones are sub-carinate on their upper and posterior edge. The dorsal margin is inflected, with some indications of a long narrow lunule.

Surface, as appears by the cast of the interior, with strong concentric undulations, three or four lines wide towards the posterior; narrower and deeper on the umbones.

Length, about two inches; height at the umbones, tenlines; depth of a single valve, six lines.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Collector.—R. Bell.

ANODONTOPSIS VENTRICOSA. (N. sp.)

Fig. 24. Fig. 25.

Fig. 24.—*Anodontopsis ventricosa.* Internal cast of left valve.
25.—Dorsal view of the same.

Description.—Strongly convex, ovate; height about two-thirds the length. Anterior extremity with the most projecting point at a little over one-third of the height, between which and the umbones the outline is gently concave. Ventral margin rather strongly convex, deepest a little in front of the middle, more abruptly rounded up to the anterior than to the posterior extremity. Umbones large, rounded; beaks closely incurved; hinge-line straight; the anterior extremity situated at about two-thirds the height; thence sloping upwards and backwards to a point on the dorsal margin a little behind the mid-length of the shell. Dorsal outline most elevated at the umbones, between which and the extremity of the hinge-line slightly concave. Posterior extremity most projecting at about the lower third; above this point obliquely truncated, ascending to the extremity of the hinge-line with a gently convex slope.

Judging from the cast of the interior, the ligament in this species is external. The dorsal margin behind the umbones is sharp, slightly compressed, gently concave just below the edge.

Surface unknown.

Length of the best preserved specimen collected, eighteen lines; height at the umbones, twelve lines; depth of both valves, ten lines.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Collector.—R. Bell.

Cypricardinia distincta. (N. sp.)

Fig. 26.

Fig. 27.

Fig. 26.—*Cypricardinia distincta.* Left valve of an elongated specimen.
27.— " " Ditto of the short form.

Description.—Shell oblong or irregularly ovate; compressed or moderately convex; an oblique, obscure angulation extending from the umbones to the posterior angle; umbones sometimes slightly flattened by an obscure depression which descends, gradually widening, to the ventral margin; beak small, closely incurved. Dorsal margin straight, slightly concave or convex, parallel with the ventral margin or a little elevated posteriorly,—usually about one-fourth shorter than the total length. Ventral margin usually gently concave, but sometimes straight or slightly convex. Anterior extremity usually with the lower half a little projecting and rounded, concave at the mid-height or obtusely rounded; posterior extremity, with the most projecting point at the mid-height or a little below, narrowly rounded or angular; the upper half obliquely truncated with a straight or gently convex slope.

Surface with wide sub-concentric rings of growth, the posterior edges of which are abruptly elevated or sub-lamellose. These rings are usually flat, but are sometimes slightly convex or concave.

The largest specimen collected is seventeen lines in length; eight lines in height at the umbones, and nine lines high at the posterior end of the hinge-line. All the others are shorter and proportionally higher. In several specimens which have both valves in connection, the right valve is the most convex.

Locality and Formation.—Indian Cove, Gaspé; Gaspé limestone, No. 8.

Modiolopsis varia. (N. sp.)

Description.—Sub-ovate, obliquely depressed convex from the umbones to the posterior part of the ventral margin, or to the lower part of the anterior margin. In the greater number of the specimens an obscure depression extends from the umbones to the ventral margin, causing a faint sinus about the middle, or a little in front thereof; umbones about one-sixth or one-fifth the length from the anterior extremity; beaks small and apparently closely incurved. Dorsal

margin more or less elevated and compressed, nearly straight to a point a little behind the mid-length; then passing with a rounded or sub-angular curve into the anterior margin. Ventral margin gently convex, often nearly straight or slightly sinuated a little in front of the middle; somewhat abruptly curved up to the anterior angle, more broadly ascending posteriorly. Anterior extremity most projecting at about the mid-height, where it is narrowly rounded; posterior margin broadly rounded, often obliquely truncated in the upper half or two-thirds.

Surface with obscure concentric rings of growth, from half to two lines wide. These are also covered with very fine obscure concentric lines.

Length of the largest specimen seen, eighteen lines. The proportions vary greatly, as may be seen by the following measurements of three specimens:

	Length.	Height at umbones.	Greatest height.
No. 1.	14 lines.	5 lines.	10 lines.
2.	15 "	8 "	11 "
3.	14 "	6 "	12 "

The form is also variable; the posterior margin being either broadly and nearly uniformly rounded or more or less distinctly angulated, usually a little below the middle.

Locality and Formation.—Between Cape Gaspé and Cape Rosier; Gaspé limestone, Lower Helderberg.

Collector.—R. Bell.

GASTEROPODA.

Murchisonia Hebe. (N. sp.)

Fig. 28.

Fig. 28.—*Murchisonia Hebe.* A cast of the interior.

See also Plate 5, fig. 6.

Description.—From three to four inches in length; apical angle about 20°; whorls, about ten in a specimen three and one-half inches in length

uniformly and moderately convex; a narrow band in the middle. Surface with fine striæ which curve backwards to the band, forming therewith an angle of about 40°.

A specimen consisting of the five last whorls and about half of the aperture is thirty-three lines in length. Width of the last whorl, twelve lines; and of the fifth whorl from the base, five lines. From the middle of the body whorl to the middle of the fifth, the length is twenty-one lines. The specimen therefore tapers seven lines in a length of twenty-one. When perfect it probably had nine or ten whorls.

Another specimen with six whorls is thirty lines in length; width of last whorl, twelve lines, and of the fifth, four and one-half lines. This specimen retains the surface markings and band on a part of the body whorl. The band is about one line in width.

Locality and Formation.—Indian Cove, Gaspé; limestone, No. 8.

Collector.—R. Bell.

Murchisonia egregia. (N. sp.)

Plate 5, fig. 7.

Description.—From three to four inches in length, apical angle about 20°; whorls apparently about ten, moderately convex; a narrow band near the basal margin of the whorl. Surface with very fine striæ, which above the band curve backwards at an angle of about 30° to the longitudinal axis of the shell; below the band they curve forward again to the suture. The band is one line wide on the last whorl of a specimen three and one-half inches in length. It is also once or twice its own width from the suture.

The specimens are somewhat distorted by pressure, and the true form of the whorls is somewhat uncertainly indicated. The following are the characters of three specimens:

1.—Length of the five last whorls, twenty-seven lines; width of last whorl, eleven lines; width of the fifth whorl from the aperture, six lines. The whorls are moderately and nearly uniformly convex, apparently most elevated in the basal half. (Pl. 5, fig. 7.)

2.—This specimen is compressed; it consists of the seven last whorls, and when perfect had about ten. The whorls are most prominent at the band, above which they have a gently convex or nearly flat slope to the suture. Length, thirty lines; width of body whorl apparently about ten lines, and of the seventh, about three lines.

3.—Consisting of four whorls: length, nineteen lines; width of the

last ten, and of the fourth from the base, seven lines. The band is very distinctly indicated and close to the basal margin of the whorl. The surface has a gently convex slope.

In its proportions this species is very near *M. Hebe;* but the position of the band distinguishes it therefrom. It also occurs in a higher formation.

Locality and Formation.—Head of the Falls of the Dartmouth River; Gaspé sandstone.

Collector.—R. Bell.

PLEUOTOMARIA PRINCESSA. (N. sp.)

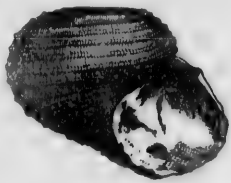

Fig. 29.

Fig. 29.—*Pleuotomaria princessa.*

Description.—The only specimen of this species collected consists of the two last whorls. From these it would appear that the apical angle is about 80°. The transverse section of the whorls is nearly circular. On the upper margin of the whorls, next the suture, there is a band which is about two and one-half lines wide at the aperture, and becomes gradually narrower above. At its outer edge there is a narrow sharply elevated keel which may represent the respiratory band. Where it terminates there is a small notch in the lip. The remainder of the surface is ornamented by a number of spiral ridges, each less than half a line in width, and about a line distant from each other. As the whorls increase in size, new ridges are intercalated between the old. These are crossed by fine, sub-lamellose, vertical striæ, four or five in the width of one line. In crossing the ridges the striæ are all curved backwards.

The umbilicus, in this specimen, is concealed, and must be, judging from the form of the basal whorls, very small. The form of the apex is not clearly indicated, but it appears to have been much depressed, or nearly flat, as represented in the figure. It may be that this appearance is due to pressure, or the absence of the apical whorl.

Locality and Formation.—Between Cape Gaspé and Cape Rosier.

Collector.—Sir W. E. Logan.

PLATYOSTOMA AFFINIS. (N. sp.)

Plate 5, fig. 2.

(Compare *P. ventricosa*, Conrad.)

Description.—Shell depressed, conical; of about four rounded whorls, the last of which sometimes exhibits a tendency to become vagrant; apical angle about 90°. Surface with fine transverse striæ, and often with a few obscure undulations. Width of a large specimen at the base, two and one-half inches; height about the same.

The specimens are all casts of the interior, with only faint indications of the surface markings. In some the whorls are evenly rounded, the most projecting part being about the middle. In others the most prominent point is below the mid-height of the whorl, and in such the spire is somewhat oblique. In large specimens, the aperture is expanded downwards, as shown in fig. 2, pl. 5. The umbilicus has not been distinctly seen, but from appearances it must be very small. When a considerable portion of the last whorl is broken off, the shell appears to be more erect as in the following figure.

Fig. 30.

Such specimens when compared with a large individual, might be taken for a distinct species. Often the spire is somewhat more depressed and rounded. The body whorl is much larger in some specimens than it is in others.

This species is closely allied to *P. ventricosa* of the Oriskany sandstone. It differs therefrom in having a more elevated spire and in being more erect. Some specimens are so much like *P. ventricosa*, that it would be difficult to point out sufficient to separate them. But when we place a group of a dozen specimens of *P. ventricosa* alongside of a similar

number of *P. affinis*, the difference at once becomes apparent. Few naturalists would refer the two groups to the same species.

Locality and Formation.—Indian Cove, Gaspé; limestone No. 8.

Collectors.—R. Bell, T. C. Weston.

Pleurotomaria voltumna. (N. sp.)

Plate 5, figs. 5, 5a.

Description.—Shell sub-turbinate or sub-globose; apical angle between 90° and 100°; spire consisting of about three rounded or obscurely lenticular whorls with a three-grooved band about the mid-height; aperture obscurely sub-rhomboidal, with, apparently, a tendency to become effuse at the lower angle; umbilicus very small. Surface with rather coarse tranverse striæ, about three in the width of one line, curving backwards from the suture to the band. Width, fifteen lines; height, thirteen lines; width of the band near the aperture, about two lines.

Of this species only one imperfect specimen has been collected. The surface of the whorl, above the band, slopes upwards to the suture, with a gently convex curve, slightly more flattened just above the band than near the suture. The same form prevails below the band where the curve of the surface, at first moderate, becomes abruptly convex around the umbilicus.

The band, in this specimen, consists of three concave grooves, the lower one, as seen on the body whorl, being the largest, and the upper the smallest, the three near the aperture occupying a width of about two lines.

Locality and Formation.—Grand Grève, Gaspé; Gaspé limestone No. 8.

Collector.—R. Bell.

Pleurotomaria delia. (N. sp.)

Plate 5, fig. 3.

Description.—Turbinate; base convex; spine of three or four whorls, obliquely conical; apical angle 90° or a little more; a band about the mid-height; umbilicus minute or closed; height, about twelve lines; width, fifteen to eighteen lines. The base of the body whorl is strongly convex; the band on approaching the aperture is situated above the mid-height, but receding therefrom it gradually gains a position on the outer edge of the whorl; in the upper whorls it seems to be concealed in the suture. The upper side of the body whorl, near the aperture, above the band, ascends with a gently convex or nearly flat slope to the suture; approaching the apex

the whorls become more convex. The band appears to be rounded and about one line wide at the aperture. The aperture is somewhat effuse below. Surface with fine striæ and some stronger ridges of growth near the aperture.

Locality and Formation.—Grand Grevé, Gaspé; limestone No. 8.
Collector.—R. Bell.

Pleurotomaria lydia. (N. sp.)

Plate 5, figs. 4, 4*a*.

Description.—Sub-turbinate, turreted; spire of three or four whorls, somewhat oblique; apical angle 90° or a little greater; umbilicus open, about one-fourth the width of the base. Height, ten or twelve lines; width, twelve or fourteen lines. The outside of the body-whorl, near the aperture, is nearly vertical, gently convex, more rounded as it recedes towards the apex. The band is situated on the upper outer margin of the whorl, and is indicated in this position, on the cast of the interior, nearly to the apex. Above the band the surface of the whorl is nearly flat, and nearly at a right angle to the vertical axis of the shell at the aperture, but becomes more convex as it approaches the apex. The umbilicus appears to be about one-fourth or one-third the whole width of the base. The aperture appears to be somewhat effuse at the lower angle. The base of the whorl around the umbilicus is uniformly convex, becoming obscurely angular at the aperture.

Surface with fine striæ, curving backwards above the band and forwards below.

Locality and Formation.—Indian Cove, Gaspé; limestone No. 8.
Collector.—R. Bell.

Bellerophon plenus. (N. sp.)

Plate 5, figs. 8, 8*a*, 8*b*.

Description.—The casts of the interior of this species are broadly rounded on the dorsum; narrowly convex around the umbilicus; the aperture transversely expanded. In the tranverse section the inner side of each whorl is indented to the extent of one-third, by the dorsum of the preceding whorl. The umbilicus, measured across from the most projecting points of the whorl around it, is about one-third the whole diameter of the shell. It diminishes in width rapidly inwards. The keel appears to be about one line wide at the aperture. None of the surface characters are seen on the casts, except some obscure wrinkles on the dorsum which

diverge from the keel forwards and outwards, forming with the keel an angle of about 45°. Transverse diameter of the aperture of a large specimen, eighteen lines; vertical diameter (from the dorsal side of the aperture to the opposite side of the shell) about the same.

Locality and Formation.—Indian Cove, Gaspé; limestone No. 8.

Collector.—R. Bell.

CRUSTACEA.

Proetus phocion. (N. sp.)

Fig. 31.—*Proetus Phocion.* In this figure the neck-furrow is a little too far behind the eyes.

Description.—Oblong-ovate; both extremities uniformly rounded, the pygidium more broadly so than the head; sides of the thorax parallel. The head is rather strongly convex, semi-elliptical; its length a little greater than half its width at the base; front smoothly rounded; sides gently curved; posterior angles with very short spines. The marginal border is well developed: it has a shallow median groove which is most distinct around the front, and down the sides, but dies out on approaching the posterior angles of the head; the border is separated from the cheeks by a distinct groove, which runs all around the sides and front of the head, touching the front of the glabella in specimens with the crust preserved. When the crust is not preserved, the front of the glabella, as seen in the cast, does not quite reach the cast of the groove. Glabella regularly conical, about one-seventh shorter than the head, convex, most elevated between the eyes. There are indications of glabellar furrows, but they are too indistinctly seen in the specimens to be located with certainty. Neck-furrow crossing the glabella, very nearly on (but a little behind) a line connecting the posterior corners of the eyes. It is nearly straight for about one half of its length in the middle, and then turns forward, slightly, at each end to the eye. The neck-segment has a small tubercle in the

middle and at each end is partially cut off, by a short groove which extends downwards and outwards from the neck-furrow; the part above the groove having somewhat the appearance of a large triangular tubercle. Eyes large, semi-circular, in contact with the sides of the glabella.

Thorax of ten segments: axis rather strongly convex; about as wide as the lateral lobes. Pleuræ geniculated at an obtuse angle, at a little less than half their length from the axial furrows; strongly facetted in the outer half. Pleural groove most distinctly impressed about the mid length of the pleuræ, not reaching the outer extremities.

Pygidium not so convex as the head; nearly semi-circular; a narrow convex border all around the sides and posterior extremity; axis conical, extending to the marginal border. There are ten or eleven segments in the axis, and six or seven (each with an obscure median groove) in the sides lobes.

Length of an entire specimen, seventeen lines; width, eleven lines; length of head, six lines; of the thorax, seven lines; of the pygidium, five lines.

Locality and Formation.—Indian Gove, Gaspé; limestone, No. 8.
Collector.—T. C. Weston.

2.—*On some new species of Fossils, from the Primordial rocks of Newfoundland.*

The following species were collected by A. Murray, Esq., Director of the Geogical Survey of Newfoundland, and described by me in the *Canadian Naturalist*, New Series, Vol. VI, July, 1872. (E. B.)

In Mr. Murray's "Report upon the Geogical Survey of Newfoundland for the year 1870," the Primordial rocks of the south-easterly portion of the Island are estimated to have a thickness of about 6000 feet. The upper 476 feet, constituting Bell Island, in Conception Bay, a short distance from the city of St. Johns, hold a peculiar group of fossils, the exact age of which has not yet been determined. The species thus far collected consist entirely of *Lingulæ*, *Cruziana* and fucoids. Among the latter are fine specimens of several species of *Eophyton*, a genus first discovered on this continent by Mr. Murray. The *Lingulæ*, on a superficial examination, might be taken for those of the Upper Potsdam of Wisconsin. They are, however, specifically, and two of them are, perhaps, even generically, different. These two are distinguished by the remarkable convexity of the dorsal valve. They have their nearest representatives in

Brittany, France, considered to be about the base of the Lower Silurian In Newfoundland, up to the present time, true primordial trilobites have been collected, only in beds, the highest of which are full 2000 feet below the lowest strata of Bell Island.

I shall therefore describe the fossils of this Island as a distinct division.

FOSSILS FROM GREAT BELL ISLAND.

Genus Eophyton, *Torell.*

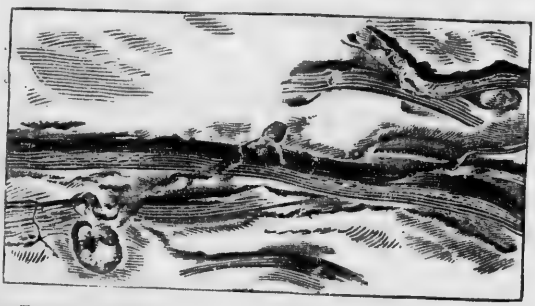

Fig. 32.—*Eophyton Linnæanum*? Torell. Part of a slab or sandstone with several fragments supposed to be of this species.

The only specimen I have access to at present is a slab of sandstone, about fifteen inches in length and twelve inches wide, on the surface of which there are about thirty stems of the fossil. Most of these lie across the stone in a direction nearly parallel to each other. They appear to have been, when perfect, slender, cylindrical, straight, reed-like plants, about three lines in diameter, with the surface longitudinally striated; four striæ upon an average in the width of one line. Some of the stems, which have been partially flattened by pressure, are coarsely grooved or fluted; but when the surface of such is perfect, the fine striæ can always be seen on the large ridges and in the furrows between them. When pressed quite flat some of the stems only exhibit the fine striæ. I cannot see that any of the stems are branched. One of them, which is pressed flat, is bifurcated, but I think this due to the pressure, which has split the stem into two portions.

I refer this species as above, because it is impossible to distinguish it from some of the figures of the Swedish form. As it occurs above the *Paradoxides* beds, while the Swedish specimens, have as yet, only been found below, it is most probably a distinct species.

EOPHYTON JUKESI. (N. sp.)

In this species the stems are nine lines in diameter, cylindrical, straight or slightly flexuous. They are longitudinally striated, but the surface of the specimens examined are not sufficiently well preserved to exhibit the dimensions of the striæ. It is separated from the former principally on account of its much greater size.

ARTHRARIA ANTIQUATA. (N. gen. and sp.)

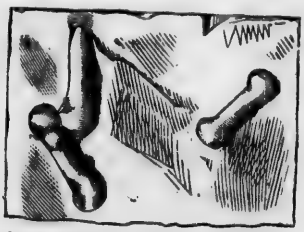

Fig. 33. Part of a slab of sandstone with *Arthraria antiquata.*

The fossils for which the above generic and specific names are proposed, are small cylindrical bodies, with usually an expansion at each end, giving the form of a dumb bell. Those that I have seen are from six to nine lines in length, and, from the manner in which they are grouped upon the surface of the stone, they appear to me to be segments of a jointed plant. They exhibit no internal structure, but the form is very constant. Similar forms occur in the Clinton formation.

LINGULA MURRAYI. (N. sp.)

34. 35. 36.

FIG. 34. *Lingula Murrayi.*
35. *Lingulella? affinis,* ventral valve.
36. " *spissa, a,* ventral valve; *b,* dorsal valve; *c,* side view of both valves.

Description.—Shell elongate, sub-pentagonal; front margin straight or gently convex for a space equal to about two-thirds the width in the middle; anterior angles rounded; sides somewhat straight or very gently

convex or parallel for two-thirds the length, then converging to the apex, where they meet at an angle of between seventy and eighty degrees. In one of the two specimens collected there is a flat margin on each side one-sixth the whole width of the shell. Between these two flat margins the remainder of the shell is gently convex. In the other specimen this central space is slightly convex in the anterior part of the shell, but on approaching the beak it becomes an angular roof-shaped ridge. The shell is thin, black and shining with obscure fluctuating, concentric undulations of growth, and with very fine, obscurely indicated, longitudinal striæ.

Length, nine lines; width, five lines.

LINGULELLA? AFFINIS. (N. sp.)

Fig. 35.

Description.—Ventral valve elongate, conical or acutely triangular Apical angle about 45°. Front margin gently convex in the middle, rounded at the angles; sides nearly straight, uniformly converging from the anterior angles to the beak. Surface with very fine longitudinal striæ about ten in the width of one line.

This species is founded upon the single specimen of a ventral valve above figured. The upper two-thirds is partly worn away in the middle leaving only the outline in the stone. It appears to have been, when perfect, gently convex, the rostral portion near the beak semi-cylindrical. Length, about thirteen lines; width, nine lines.

The dorsal valve has not been identified.

LINGULELLA? SPISSA. (N. sp.)

Fig. 36, a, b, c.

Description.—Shell sub-pentagonal, or sub-ovate; length and width about equal, sometimes strongly ventricose. Dorsal valve with the front margin straight or very gently convex for about two-thirds the width in the middle; anterior angles rounded; sides straight or slightly convex and sub-parallel until within one-third or one-fourth the length from the beak, then converging to the apex, where they form an obtuse angle which varies from 100 to about 110 degrees. This valve is generally very convex, sometimes almost hemispherical, the outline on a side view is rather abruptly elevated in the rostral third, depressed convex for a short space in the middle, and then more gently descending to the front margin. Most of the specimens of this valve are eight or nine lines in length, and about the same in width.

The shell, which is supposed to be the ventral valve of this species, is gently convex, with usually a somewhat flat space extending from the front margin upwards towards the beak. The apical angle appears to be from 90 to 100 degrees. Shell very thick, of a lamellar structure, dark brown or nearly black, and, sometimes, where exfoliated, of an ashy gre colour. Surface with a number of obscure undulations of growth and with fine longitudinal striæ, about ten in the width of one line.

CRUZIANA SIMILIS. (N. sp.)

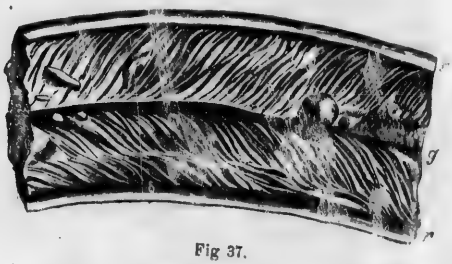

Fig 37.

Fig. 37. *Cruziana similis*; *g*, the median groove; *r*, *r*, the ridges at the sides.

Description.—The specimens are from twelve to fifteen lines wide, divided along the middle by an angular groove, and bordered on each side by a narrow ridge, about one line wide. The spaces on each side between the median groove and the marginal ridges are moderately convex and crossed obliquely by numerous irregular raised lines, with furrows between them. These lines usually have the form of a gentle sigmoid curve, sometimes extending quite across, but are often crowded together in a somewhat confused manner, still preserving the general oblique direction. Upon an average there are about ten lines in the length of half an inch. The marginal ridges are sometimes longitudinally striated.

This species has been heretofore referred by me to *C. semiplicata*, Salter, but, although closely allied, none of our specimens agree exactly with the figures of the British species.

Besides the above six species, many of the beds of sandstone of Great Bell Island are covered with several species of *Palæophycus* and other forms allied to *Eophyton* and *Cruziana*. To describe these would require further collections. In the upper strata there are yet two or three new species of *Lingula*, of which we have only fragments.

FOSSILS FROM THE MENEVIAN GROUP.

Below the strata of Bell Island there are about 2000 feet consisting of sandstones and slates, in which no fossils have been found except a few fucoids. These with the Bell Island rocks may represent the Middle and Upper Lingula Flats. They are immediately underlaid by about 2000 feet of slates, sandstones and limestones, holding fossils which prove them to be of the age of the Lower Lingula Flags, or the Menevian group of Salter and Hicks. Fossils in some of the beds are abundant but very imperfect. The following are all that are sufficiently well preserved to admit of description :

OBOLELLA? MISER. (N. sp.)

Description.—Shell small, transversely broad ovate, nearly circular; width slightly greater than the length. Ventral valve strongly convex, depressed conical; greatest elevation at about one-third or one-fourth the length from the hinge line. The latter appears to be straight, and about one-fifth the width of the shell. In the apex, or the most elevated point of this shell, there is an irregularly circular aperture or depression. The dorsal valve is less convex than the ventral, but more uniformly so, the greatest elevation near the centre; beak apparently curved down to the level of the hinge line.

Surface to the naked eye apparently smooth, but when magnified showing very fine concentric striæ. The width of the largest specimen of the dorsal valve seen is about one line; length, a little less. This species occurs at Chapel Arm, in Trinity Bay.

Mr. Davidson has figured and described* under the name of O. *sagittalis*, Salter, a species from the Menevian group, North Wales, which is closely allied to this, the only difference (so far as can be made out without comparisons of specimens) being, that the English species is about double the size of ours. As I understand Mr. Davidson, what appears to be an aperture, in the apex of the ventral valve, is not truly such, but an impression made in the cast of the interior by a tubercle on the inside of the shell.

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* On the earliest forms of Brachiopoda hitherto discovered in the British Palæozoic rocks; by Thomas Davidson, Esq., F.R.S., Geological Magazine, Vol. 5, No. 7, July, 1868.

STRAPAROLLINA REMOTA. (N. sp.)

Fig. 38.

Fig. 38. *Straparollina remota*, *a*, view of the spire; *b*, oblique view of anterior side.

Description.—Shell small hemispherical, spire depressed and rounded in outline; height, two to three lines, width three to four lines; whorls about three; suture deep. The whorls are nearly uniformly rounded, more narrowly so on the upper side, close to the suture, and also on the basal side. On a side view the minute apical whorl is scarcely at all seen; the next below it is elevated about half its own diameter above the body whorl. In a specimen four lines wide, the width of the aperture is about one and one-half lines, as nearly as can be determined from an individual party buried in the matrix. Surface nearly smooth.

Occurs at Smith's Sound, Trinity Bay.

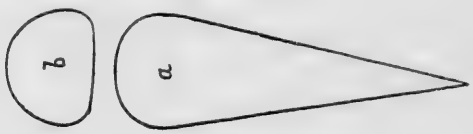

Fig. 39.

Fig. 39. *Hyolithes excellens.* In these diagrams, *a*, represents the rate of tapering on the ventral side; *b*, the transverse section. The dorsal side of *b* is too broadly rounded.

HYOLITHES EXCELLENS. (N. sp.)

Description.—Shell usually about two inches in length, tapering at the rate of between four and five lines to the inch. The ventral side is nearly flat or very gently convex; the lateral edges narrowly rounded, in some specimens rounded angular; the most projecting parts of the sides are about one-third the height; above this the sides are gently convex, the dorsum more narrowly rounded. The shell is thin, nearly smooth, with very fine obscure striæ, about ten in one line. The striæ curve forwards on the ventral side, forming an arc the height of which is equal to about one-third the width of the shell. On crossing the lateral edges the striæ curve backwards, until they reach the most projecting part of the sides, then cross up and over the dorsum at a right angle.

On a side view the shell is gently curved downwards on approaching the apex.

A specimen twenty-four lines in length on the ventral side is eight and one-half lines wide and six lines in depth at twenty lines from the apex.

Occurs in the red limestone at Smith's Sound, Trinity Bay.

Fig. 40

Fig. 41.

Fig. 40. *Agraulos socialis.* The head without the moveable cheeks. The glabella is too distinctly defined in this figure.

Fig. 41. *Agraulos strenuus.*

Agraulos socialis. (N. sp.)

Description.—Head (without the moveable cheeks) semi-elliptical or conical, width at the base a little greater than the length, gently convex. Glabella conical and (including the triangular projection backwards from the neck-segment) about two thirds the whole length of the head, neck-furrows all across but obscurely compressed; neck-segment with a triangular projection backwards, terminating in a short, sharp spine. Fixed cheeks, gently convex; front margin sometimes with a portion in front of the glabella thickened. Eyes of moderate size are situated on a line drawn across the head at about the mid-length, distant from each other about the length of the head. Surface nearly smooth.

In small perfect specimens no trace of glabellar furrows can be seen but in some of the large ones four or five obscure furrows are exhibited.

The largest specimen seen is six lines in length and seven in width. It occurs at Chapel Arm, Trinity Bay.

Fig. 41.

Agraulos strenuus. (N. sp.)

Description.—Head (without the moveable cheeks) irregularly quadrangular, broadly rounded in front. Glabella rather strongly convex, conical, variable in its proportional length and width, either smooth or with several obscure impressions on each side representing the glabellar furrows; neck segment with a strong triangular projection backwards; neck furrows all across but usually obscurely impressed. In some specimens the front of the head has a thick, convex marginal rim separated from the front of the glabella by a narrow groove. In others this rim is scarcely at all

developed. The eyes, shown by the form of the lobe, appear to have been semi-annular and about one-third the length of the head. The surface appears to be smooth. The following are the dimensions of the best preserved specimen:

Length of the head, including the large posterior projection, six lines; width of the convex marginal rim, one line; width of the groove between the rim and the [illegible] glabella, one-third of a line; length of the glabella including the [illegible]jection, five and two-thirds lines; width of the glabella at the posterior margin, three lines; width of the fixed cheek from the centre of the edge of the eye-lobe to the side of the glabella, two lines. A line drawn across the head at two and a quarter lines from the front margin would pass through the anterior angles of the eyes. The length of the eye appears to be nearly two lines.

As above remarked, this species varies somewhat in its proportional length and width, and hence the dimensions, above given, would not be found to be exactly parallel in all the specimens.

Occurs in the grey limestone of Topsail Head and also in the pinkish limestone of Brigus, Conception Bay.

Agraulos affinis. (N. sp.)

Description.—This species is closely allied to *A. socialis* and is of the same size, but differs in the following respects. The glabella is broader, and with the sides gently convex. The eyes are somewhat nearer the sides of the glabella. The whole of the anterior portion in front of the glabella is convex. The dorsal furrows are more distinctly impressed all around the glabella.

It occurs at Branch, St. Mary's Bay.

Genus Conocepalites.

This genus has been used as a general receptacle for a number of groups which, according to several authors, constitute distinct genera. Although it has been found very convenient, there has lately sprung up a disposition to dispense with it altogether. I have no doubt but that this will be done, and I shall therefore dispose of our species as follows.

Solenopleura communis. (N. sp.)

Description.—Glabella conical, convex, about two-thirds the whole length of the head, about one-third wider at the neck-furrows than at the front; on a side view considerably elevated above the fixed cheeks.

neck-furrow well defined all ac ; neck-segment thickened in the middle and bearing a small tuberc e. The fixed cheeks are strongly convex, but not so prominent as the glabella. The dorsal furrows are deeply defined all around the glabella. The front margin has a strong rounded rim, separated from the front part of the cheeks by a narrow, but distinct, groove; between the groove and the front of the glabella, there is a gentle depression, which separates the anterior angles of the fixed cheeks. The eyes are small, situated a little in advance of the mid-length of the head, distant from the side of the glabella a little less than half the length of the head, and are connected with the front of the glabella by an obscure ocular fillet. Surface with a few scattered tubercles, just visible to the naked eye, and between these numerous minute tubercles only seen when magnified.

The glabella exhibits traces of two or three obscure furrows on each side. Length of the largest head collected five lines.

Occurs at Chapel Arm, Trinity Bay.

Fig. 42.

Fig. 42 *Anapolenus venustus.*

Anapolenus venustus. (N. sp.)

Fig. 42.

Description.—Glabella convex, most elevated in front, obscurely angular along the median line, widest at the anterior third of the length; sides gently concave in the posterior two-thirds, and slightly diverging from each other forwards; anterior third and front uniformly rounded. Neck segment with the margin convex and projecting backwards, an obscure tubercle, or rather, an angular elevation in the middle, neck furrows all across. There are four glabellar furrows; of these the posterior is strongly marked and extends in a nearly straight line all across; the next two are linear, slightly impressed, extend inwards about one-third the width of the glabella and are gently curved backwards, but still almost at right angles to the sides. The anterior furrow is short, extends inwards about one-fifth the width of the glabella, and curves backwards at an angle of about 45° to the sides. The dorsal furrow around the glabella is very shallow. The fixed cheeks are triangular, nearly flat, with a small elevation, close to the extremity of the posterio-

furrow. Front of the head with a moderately convex marginal rim, almost in contact with the glabella or separated therefrom by a narrow space. The eye-lobe starts from a point close to the side of the glabella and just opposite or a little behind the short frontal furrow, and runs with a gently sigmoid curve (at first convex outwardly, and then concave) backwards and outwards to the posterior marginal furrow, which it reaches at a distance from the sides of the glabella, about equal to the length of the neck segment. The facial suture leaves the side of the glabella a little in front of the anterior furrow, and runs outwards, nearly at a right angle, but with a gentle convex curve, to the margin.

The surface is covered with fine rippled striæ. These on the marginal rim are irregularly parallel with the margin; on the glabella they curve around the front, but further back, and on the neck segment they have a rudely longitudinal direction, curving outwards in crossing over the glabellar lobes.

Length of the head of the largest specimen examined, six lines; length of the glabella, including neck segment, five lines; width of glabella at the neck segment, three lines, at the front pair of furrows, three and a half lines; width of the posterior margin of the fixed cheek, three lines; length of the eye lobe, four lines.

When compared with the species figured by Salter and Hicks the following difference becomes apparent:—*A. Henrici*, Salter, has the eye lobes with a gently uniform curve outwards. In *A. Salteri*, Hicks, the eye lobes are also convex and the glabella proportionally longer, while the neck furrow "is the only one continued across." (Hicks.) *A. impar*, Hicks, has the flexuous eye lobes of our species, but the marginal rim is more decidedly in contact with the front of the glabella, while the two median pairs of furrows extend further inwards.

Occurs at Chapel Arm, Trinity Bay.

PARADOXIDES TENELLUS. (N. sp.)

Fig. 43 *Paradoxides tenellus.*

Fig. 43.

Description.—Glabella clavate, convex, most elevated at the anterior third of the length, front and sides in the anterior half, rounded, becoming sub-parallel in the posterior half. Neck segment strongly elevated in the

middle, where there is situated a small tubercle, neck furrow extending all across. There are four glabellar furrows, of which the posterior extends across but is very indistinctly impressed in the middle; the next two in advance extend inwards about one-third of the width of the glabella, while the small one in front is somewhat shorter. The furrows are all nearly at a right angle to the longitudinal axis, and about equidistant from each other. The anterior margin of the head is bordered by a narrow convex rim, which is separated from the front of the glabella by a flat space, varying in width from once to thrice its (the rim's) width. The fixed cheeks are sub-triangular and nearly flat. The anterior extremity of the eye lobe is situated at a point nearly opposite, but a little behind, the anterior furrows, and is close to, but not in contact with the side of the glabella. The lobe is slightly sigmoid, its posterior extremity opposite the last glabella furrow. The dorsal furrow is distinctly impressed along the posterior half of the glabella but obscurely marked in front.

The surface is minutely granular. In all of the three specimens collected there is a small straight rounded ridge, which runs from the front of the glabella to the margin. It is situated exactly on the median line.

Of this species we have three specimens of the glabella, two of which retain portion of the fixed cheeks and show the form of the eye. The largest is three lines in length, including neck segment and front margin.

Occurs at Chapel Arm, Trinity Bay.

PARADOXIDES DECORUS. N. sp.)

Description.—The form of the glabella of this species is nearly the same as that of *P. tenellus*, but the glabellar furrows are somewhat different. The posterior pair seem to be entirely disconnected in the middle and the next two pairs are rather more curved. The marginal rim of the front of the head seems to be close up to, and in contact with, the front of the glabella. The surface is ornamented with minutely corrugated, raised lines which, in some places, anastomose so as to present an irregularly reticulated appearance. This at once separates the species from *P. tenellus*, the surface of which is minutely granulated. The surface of *A. venustus* is somewhat like that of this species, but the raised lines are more distant, and besides the posterior glabellar furrow extends all across. The length of the most perfect glabella examined is about thirteen lines. Only three fragments (all of the glabella) of this species occur in the collection. Form of the eyes and of all other parts unknown.

It occurs at Chapel Arm, Trinity Bay.

IPHIDEA BELLA. (N. gen. and sp.)

FIG. 44. *Iphidea bella*; ventral ? aspect.

Of this genus we have no specimens showing the internal structure, but the external characters seem sufficient to separate it from any described generic group. The ventral ? valve of *I. bella*, is conical, strongly elevated at the beak, hinge-line nearly straight, posterior angles narrowly rounded, sides and front nearly uniformly rounded, forming rather more than a semi-circle. Posterior side with a large false area, and a convex pseudo-deltidium, the width of which at the hinge-line is nearly one-third the whole width of the shell. The dorsal valve is semi-circular, moderately convex, most elevated at the beak. The hinge-line appears to be straight. The form and structure of the posterior side, (such as the area, foramen, deltidium, &c.,) cannot be made out from the specimen, owing to its imperfection. The surface is covered with fine concentric striæ, which in the ventral ? valve are continued around on the area. Of these striæ there appear to be from fifteen to twenty in the width of one line, their size varying somewhat in different parts of the specimen. There are also a few obscure radiating striæ. Width of ventral valve, seven lines; length, five lines; height, two lines.

In the specimen above figured there is an aperture in the beak, but in another there is no appearance whatever of a perforation. This genus resembles *Acrotreta*, but differs therefrom in having a large convex deltidium. It seems to be also closely allied to *Kutorgina*. The shell which I have described under the name of *Obolus Labradoricus* belongs to this genus.

I. bella was found by T. C. Weston, in a boulder of limestone associated with numerous fragmentary trilobites, of primordial age, near Trois Pistoles below Quebec. A closely allied species of the same genus occurs in the primordial limestone at Topsail Head, Conception Bay, Newfoundland.

FOSSILS IN THE HURONIAN ROCKS.

ASPIDELLA TERRANOVICA. (N. gen. and sp.)

These are small ovate fossils five or six lines in length and about one-fourth less in width. They have a narrow ring-like border, within which

there is a concave space all round. In the middle there is a longitudinal roof-like ridge, from which radiate a number of grooves to the border. The general aspect is that of a small *Chiton* or *Patella*, flattened by pressure. It is not probable, however, that they are allied to either of these genera.

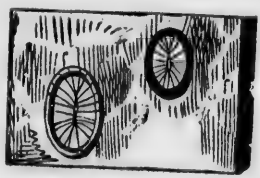

Fig. 45. *Aspidella terranovica*, two specimens on a small slab of stone, slightly restored.

Associated with these are numerous specimens of what appear to be *Arenicolites spiralis*, a fossil that occurs in a formation lying below the primordial rocks in Sweden. These fossils were first discovered by A. Murray, Esq., F.G.S., in 1866. Other specimens were collected by Capt. Kerr, R.N., Mr. Howley and Mr. Robertson.

They occur near St. Johns, in the Huronian. A more detailed description will be given hereafter.

Stenotheca pauper, (N. sp.)

Description.—Shell small, conical, with the apex incurved, laterally compressed. Aperture ovate, elongated in the plane in which the curvature of the apex occurs. Surface with four or five small engirdling convex ridges. Length of aperture about one and one-half lines; width about one line; height of shell about one line.

Occurs in the red limestone at Brigus, Conception Bay.

In the Quar. Jour. Geol. Soc. of May 1872, Mr. Hicks has described and figured, under the name of *Stenotheca cornucopia*, a small shell which is evidently congeneric with this. To the same genus should perhaps be referred the shell known as *Metoptoma rugosa* of the Lower Potsdam ? of New York.

Scenella Reticulata. (N. gen. and sp.)

Description.—Shell small, almost uniformly depressed, conical; apex central or nearly so; an obscure carina extending from the apex down one side to the margin. Aperture nearly circular, apex very slightly incurved towards the side opposite the carina. Surface reticulated with fine radiating and engirdling striæ, just visible to the naked eye. Diame-

ter of the aperture of the largest specimen collected, three lines; height of the apex, two lines.

Occurs at Topsail Head, Conception Bay.

Species resembling this have been heretofore referred to *Capulus*, *Metoptoma*, &c., to which, however, they do not belong. For the present I propose to refer those with a strongly corrugated surface to *Stenotheca*, and the others with a smoother surface to *Scenella*.

3.—*On the Genus Stricklandinia, with descriptions of the Canadian species.*

Genus STRICKLANDINIA. (Billings.) 1859.

STRICKLANDIA. (Billings.) Canadian Naturalist and Geologist, vol. 4, p. 132, April, 1859.
STRICKLANDINIA. (Id.) Op. cit. Vol. 8, p. 370, October, 1863.
—— —— (Ralph Tate.) Appendix to Woodward's Manual of Mollusca, p. 59, 1868.
—— —— (Davidson.) British Brachiopoda, vol. 3, p. 157, 1867.
—— —— (Hall.) Palæontology of N.Y., vol. 4, p. 369, 1867.

Generic Characters.—Shell usually large, elongate-oval, transversely-oval, or circular: in some species with a straight hinge-line, more or less extended; valves nearly equal, varying from depressed convex to strongly convex; a short mesial septum in the interior of the ventral valve, supporting a small triangular chamber beneath the beak as in *Pentamerus;* in the dorsal valve two very short or rudimentary socket plates, which in some species bear prolonged calcified processes for the support of the cirrated arms. Both valves with an area, that of the ventral valve the largest; the dorsal area sometimes incurved over the ventral and concealing it wholly, or in part.

No muscular impressions have as yet been clearly observed in the ventral valve, but in the dorsal there are two oblong or sub-ovate scars a little below the beak, one on each side of the median line. These were first made known by Mr. Davidson and figured in his "British Brachiopoda," vol. 3, plates 19 and 20, and they are also seen in *S. Canadensis*. The surface is usually coarsely and rather irregularly covered with radiating ridges; sometimes nearly smooth.

All the English species of *Stricklandinia* were formerly included in the genus *Pentamerus*. The first intimation of a distinction between them and the typical forms of the latter genus was published in Mr. Davidson's "General Introduction," 1854, p. 98. The characters on which this distinction was founded were discovered by the late J. W. Salter, Esq., Palæntologist of the Geological Survey of Great Britain. In his account of the internal characters of *Pentamerus*, Mr. Davidson says:—

"The position of the mesial plate and V shaped process in the dental valve has been clearly shown, both by Baron V. Buch and Professor King, to be the equivalent of the me-

sial septum and dental plates of other genera; the dimensions of these varying almost in every species; they are most developed in *Pentamerus Knightii*, where the central septa extend nearly to the frontal margin, while in other forms, such as in *P. lens*, the same plates are small and rudimentary; affording, as justly remarked by Prof. McCoy, good specific characters. The same proportions and differences are likewise observable in the arrangements of the smaller valve in *Pentamerus Knightii*, for example, the two sub-parallel longitudinal septa as well as the conjoined and inclined dental plates, are m · h extended and elevated, while in other forms they are considerably reduced, being almost rudimentary. Mr. Salter has observed that in *P. lens* the dental plates extend freely into the cavity of the shell, and that in (*P. liratus*) they are produced in the form of free, long, and narrow lamellæ, to which the cirrated arms were of course attached. The exact position and form of the different muscles has not been yet completely made out; but in some species the quadruple impressions of the adductor are clearly defined."

In Woodward's "Manual of the Mollusca," 1851–1856, p. 227, the characters in question are thus alluded to:

"Oral lamellæ have been detected by Mr. Salter in *P. liratus*; in *P.? brevirostris* (Devonian, Newton) the dorsal valve has a long trough-like process supported by a single low septum."

In the second edition of "Siluria," p. 229, (1859) Mr. Salter, to whom Sir Roderick Murchison had confided the revision and notes of the fossil data in his work, observes, while speaking of the Brachiopoda of the Llandovery rocks, that:—

"The Pentameri are, however, the characteristic fossils, which impart to this zone its peculiar and distinct facies. No less than five species, whether smooth or only slightly ribbed, occur, and of these *P. oblongus* is the best known and the most widely spread. This typical shell is easily distinguished from the other species, *P. lens* and *P. liratus*, by the great length of the mesial septum, which in these latter is quite a short appendage to the V shaped chamber. The two longitudinal plates, also, which divide the upper valve, are peculiar to this species; while in *P. lens* they are very short, and in *P. liratus* are reduced to a pair of processes which pass inwards, but do not show upon the cast."

This latter passage is quoted from Mr. Davidson's "British Fossil Brachiopoda," vol. 3, p. 160, and he adds to it:—"Lastly, Mr. Billings, availing himself of the differential characters pointed out by Mr. Salter, proposed for such shells as *P. liratus*, *P. lens*, and some other Canadian species, the generic designation of *Stricklandia*, and which he subsequently altered to *Stricklandinia*. This I will retain as a section of the large genus *Pentamerus*, and in which I trust the species under description will find a permanent home."

The genus was not founded altogether on the characters to which Mr. Davidson alludes. While st· ·ing the species in the Canadian collection, I observed that nearly all those with short plates in the dorsal valve differed in general form from those with long plates. I, therefore, proposed a new genus for their reception, and gave the following reasons for so doing:

Generic Characters.—Shell, usually large, elongate oval, transversely-oval, or circular sometimes compressed; valves nearly equal; a short mesial septum in the interior of the

ventral valve supporting a small triangular chamber beneath the beak as in *Pentamerus*; in the dorsal valve no longitudinal septa, spires, or loop, the whole of the internal solid organs consisting of two very short or rudimentary socket plates, which in some species bear prolonged calcified processes for the support of the cirrated arms. In some of the species the ventral valve has an area more or less developed.

"This group of shells, although closely related to *Pentamerus*, differs from that genus in the following particulars:—1st. In *Pentamerus* the form is globular and the ventral valve is much the largest. In *Stricklandia* the valves are nearly equal and never globose. 2nd. In *Pentamerus* the dorsal valve has two or three longitudinal septa, which in some species sustain a small triangular chamber. In *Stricklandia* these characters are entirely absent. It might be thought that the difference between the short or rudimentary dental plates of *Stricklandia* and the elongated mesial septa of the dorsal valve of *Pentamerus* is not of sufficient importance to constitute a generic distinction, because it is only a difference in the extent to which identical parts are developed, the dental plates of the former genus being a rudimentary state of the septa of the latter. When, however, we examine any group of closely allied genera we find that all the grounds for separation consist in the various modifications of the same set of organs. Were it not so then there would be no such thing as homologous parts. The difference in the degree of the development of an organ is not *always* a good character, but when it is carried to such an extent that the whole form of the animal is affected in a particular manner, manifested in a number of species, then it becomes of generic value. If we take the several species of *Stricklandia* and compare them with an equal number of species of *Pentamerus*, such for instance as *P. Knightii* *P. galeatus*, *P. Sieberi*, *P. acutolobatus*, *P. caduceus*, &c., the difference in the external form of the two groups is so remarkable that we would be almost warranted in separating them into two genera upon this ground alone; but when to the dissimilarity in the general form we add the difference in the internal structure then there can be little doubt as to the correctness of the separation."

"This genus includes three English species which have been long known under the names of *Pentamerus lens*, *P. liratus*, and *P. lævis*. All these, and the three Canadian species, abound in rocks of the age of the Middle Silurian, such as the Llandovery rocks of Sir R. Murchison, and the Clinton and Niagara groups of the New York geologists."

The following figures exhibit the difference in form between *Stricklandinia* and *Pentamerus*:—

Fig. 46.

Fig. 47.

Fig. 48.

Fig. 46. *Stricklandinia Davidsonii*, dorsal view.
" 47. do side view.
" 48. *Pentamerus Knightii*, side view.

The main differences between *Pentamerus* and *Stricklandinia* thus occur in the internal structure of the dorsal valves, discovered by Mr. Salter, and in the general form first pointed out by myself.

The name *Stricklandia* was afterwards changed by me to *Stricklandinia*, as it had been previously applied to a genus of fossil plants. (Can. Nat. Geol., vol. 8, p. 370, October, 1863.) The species cited above as *P. lævis*, should have been quoted as "*Spirifer? lævis*," figured by J. de C. Sowerby in the "Silurian System," pl. xxi., fig. 12. At the time I wrote (1859) this species was known in England not to be a *Spirifer* but a *Pentamerus*, as that genus was then understood; I therefore called it *P. lævis*. It is figured by Sowerby with a straight hinge line, sixteen lines in length. That this is the species intended by me, is proved by the following remark on p. 84, vol. 1, of this work (in the part issued in 1862.) It is there stated of *Stricklandinia*, that:—"The hinge line in some of the species, such as in *S. lævis* and *S. mocrocamerus*, have the hinge line straight and much extended." This sentence is irregular, but as its meaning is obvious I make no alteration in it. It proves clearly that the species intended by me had a long straight hinge line; and could not, therefore, have been *P. lævis*, of James Sowerby, 1813, the young of *P. oblongus*, as represented by Mr. Davidson and Prof. Hall, in the works cited below.* My generic description rigidly excludes *P. oblongus*, whether young or old. There is no resemblance whatever, between the young of *P. oblongus* (as figured by J. Sowerby) and any species of *Stricklandinia* yet described.

Stricklandinia canadensis. (Billings.) 1859.

Pl. 6, fig. 3, and pl. 7, fig. 2.

Stricklandia canadensis. (Billings.) Canadian Nat. and Geol., vol. 4, p. 135, 1859.

Description.—Shell large, sub-circular or transversely broad-ovate, compressed or sub-lenticular; surface, as indicated by the casts of the interior, covered with convex radiating ribs, and concentric step-like, sub-lamellose rings of growth.

The ventral valve is moderately convex, most elevated in the upper half or third of the length, usually strongly compressed or sub-concave towards the sides, especially in the upper two-thirds. A mesial sinus commences on the umbo, and gradually widens to the front margin, where, in large specimens, it is sometimes an inch or more in width. It is generally shallow and concave, and though always perceptible, is sometimes very slightly indicated. The dorsal valve seems to be of about the same convexity as the ventral, and has an obscure mesial fold corresponding to the ventral sinus.

* Davidson; "British Fossil Brachiopoda," vol. 3, p. 158. *Hall;* Pal., N.Y., vol. 4, p. 370.

The beak of the ventral valve exhibits in the cast a very short fissure, seldom more than two lines in depth, indicating that the mesial septum was short and thick with, sometimes, a rounded edge. One specimen shows that the tri-angular chamber, at its lower angle, projected far into the cavity and apparently almost reached the shell of the dorsal valve.

The casts of the interior of the dorsal valve show at the beak a short roof-like ridge, about two lines in length, and about the same in width. This seems to prove that in the hinge-line of the perfect shell there is an angular notch or tri-angular foramen. On each side of the ridge there is seen one of the small pits occupied by the crural processes.

No traces of the muscular impressions of the ventral valve are visible in any of our specimens. In the dorsal valve they are small (in proportion to the large size of the shell), and situated immediately below the beak. They are of an ovate or oblong shape, divided along the middle. In a specimen four inches in length the scars are seven lines in length and five lines in width.

The concentric markings, on the surface, show that the shell was subject to occasional interruptions of its growth. They also give very distinct outlines of the form at different ages, from that of the young shell, one inch in length, up to the old ones, of five inches.

The radiating ribs along the middle proceed straight to the front, but at the sides they curve outwards, those near the hinge line reaching the margin at about a right angle to the length of the shell, sometimes even slightly curved upwards. They are, as seen in the cast, low, rounded, usually about one line or a little less. They appear to increase by bifurcation and intercalation. In most specimens, they are crossed by obscure concentric crenulations.

Length of large specimen, four or five inches. The width appears to be a little greater. Depth of both valves, one inch and a half.

This species is closely allied to the English *S. liratus*, but is a much larger shell. In a collection of fossils from Gothland, sent to the Survey by Dr. Lindstrom, there are three specimens of the Swedish form that have been referred to *S. liratus*. They are decidedly distinct from our shell.

Locality and Formation.—Near Thorold, Ontario, in the Clinton formation.

Collectors.—A. Murray, E. Billings.

STRICKLANDINIA GASPEENSIS. (Billings.) 1859.

Plate 6, fig. 4a.

STRICKLANDIA GASPEENSIS. (Billings.) Canadian Nat. and Geol., vol. 4, p. 134, 1859

Description.—Shell large, oval, greatest width about the mid-length or a little in front thereof, the anterior half usually more broadly rounded than the rostral half; length to breadth about as five is to four; valves nearly equally and rather strongly convex. The ventral valve in a large specimen is about three lines longer than the dorsal, (the excess of length being at the umbo and beak); beak small, closely incurved down and touching the umbo of the dorsal valve, the point of contact being rather on the ventral side of the plane of the lateral margin; umbo convex, the cardinal angles somewhat compressed; area from one-fifth to one-fourth the width of the whole shell in length; strongly incurved on each side of the beak, becoming flat towards the margin, where it forms an obtuse angle to the length of the shell. The tri-angular chamber reaches the beak, and forms a large foramen in the area; inwardly it projects nearly to the shell of the dorsal valve.

Fig. 49.

Fig. 49 STRICKLANDINIA GASPEENSIS. Dorsal view of a large specimen; of the variety with truncated front margin.

On the umbo of the ventral valve, a mesial sinus commences, which gradually increases in width to the front margin; more than half of which is affected by it. The dorsal valve has a mesial elevation, on each side of which there is a sinus of just sufficient strength to induce the idea of a trilobed surface. The area of this valve is incurved over that of the ventral valve and almost entirely conceals it, at the same time completely closing the foramen. The socket plates are exceedingly small, no traces of them being seen in a cast of the interior of the umbo, which is perfect to within one line from the edge of the ventral area.

The surface is covered with strong, rounded, radiating ribs, increasing in number both by bifurcation and intercalation. The width of the fully developed ribs is about one line, but in some places on the surface, where the ribs are newly divided, there are often to be seen four or five of them in the width of two lines. The shell is subject to interruptions of growth, and in such cases the form of its younger stages is very distinctly represented on the surface.

The front margin is sometimes uniformly rounded, often with a sinus in the middle, as in the specimen figured, while others exhibit an obscure projecting lobe in place of the sinus.

The length of large specimens is about four inches; width, three inches and a half; depth of both valves, two and a half inches.

Locality and Formation.—L'Anse à la Vieille on the Bay of Chaleurs. Middle Silurian.

Collector.—Sir W. E. Logan.

STRICKLANDINIA BREVIS. (Billings.) 1859.

Plate 6, figs. 2, 2a, 2b, 2c.

STRICKLANDINIA BREVIS. (Billings.) Canadian Nat. and Geol. vol. 4 p. 135. 1859.

Description.—Transversely sub-ovate or sub-pentagonal; hinge line straight, equal to about two-thirds the greatest width; cardinal angles rounded; greatest width a little above the mid-length, in front of which the sides converge with a gentle curve to the middle of the front margin. Both valves moderately and about equally convex, most prominent at about one-third the length from the beak. Ventral valve with a concave mesial sinus, which commencing at the beak gradually widens to nearly one-third the whole width of the shell. The sides and cardinal angles somewhat compressed. Umbo small; beak closely incurved, touching the dorsal valve; area concealed. Dorsal valve with a rather strong mesial fold which, at the front margin, is about one-third the whole width of the shell; on each side of the fold, a slight longitudinal depression. The beak seems not to overhang the hinge line, but is slightly elevated in the plane of the lateral

margin. Surface covered with obscure, rounded, radiating ribs about half a line in width, and with some faint concentric, apparently crenulated striæ.

Of this species only one perfect specimen has been collected. Length, one inch; width, sixteen lines; depth of both valves, seven lines. Associated with it were found broken specimens which indicated a width of from two to two and a half inches.

Locality and Formation.—South West Point, Anticosti, Middle Silurian.
Collector.—J. Richardson.

(The following is from the Geological Magazine, vol. 5, February, 1868, with some slight alterations.)

"In the 'Canadian Naturalist and Geologist,' vol. 4., p. 184, figs. 8-9 (1859), I figured a small specimen of a species of *Stricklandinia* under the name of *S. lens;* but, at the same time, stated that I was not certain whether it was the true *S. lens* or a variety. It was more pointed in front than any of the English specimens I had seen. It had been collected in the Middle Silurian rocks on the Island of Anticosti, along with numerous other specimens, most of them in a fragmentary condition. Among these I thought that *S. lirata* could also be identified; and thus both of the British species have been cited in several of the publications of our Survey.

"Through the kindness of the author I received, several months ago, 'Part 2' of Mr. Davidson's 'Monograph of the British Silurian Brachiopoda.' The clear descriptions and beautiful illustrations of this magnificent work at once enabled me to perceive that we have not (so far as yet known) either of the two species above mentioned. What I supposed to be *S. lirata,* is the adult of the form figured by me as *S. lens.* The young and small individuals are smooth; but with increasing size and age they become more and more strongly ribbed.

"While re-examining the whole collection, with a view to this paper, I broke up several pieces of limestone, which were almost entirely composed of the imperfect and detached valves of another species, and succeeded in getting out several specimens, sufficiently perfect to authorize a description. We have thus two new species; and, as the error with regard to *S. lirata* and *S. lens* has been transferred from my publications into several important English works, it is thought advisable to describe them in the GEOLOGICAL MAGAZINE at once, without waiting for my next report, which cannot be issued for several months."

STRIKLANDINIA DAVIDSONII. (Billings.) 1868.

Plate 6, figs. 1, 1a, 1b, 1c, 1d.

STRICKLANDINIA DAVIDSONII, (Billings). Geological Magazine, vol. V. p. 59, pl. IV., Jan. 1868.

Description—"Shell longitudinally ovate; sides and cardinal extremity rounded; front usually with a linguiform extension about one-third of the whole width, and of variable length, sometimes simply narrowed from the mid-length to a round point; greatest width about the middle, or a little above. The valves are almost equally convex. The ventral valve has, in young individuals, an obscure mesial sinus, which becomes obsolete with age; towards the front this sinus often gives place to a well-developed fold. Some of the large individuals have neither fold nor sinus in this valve. The dorsal valve usually exhibits a fold, which becomes gradually broader from the beak to the front, where its width is equal to that of the tongue-like projection. The umbones and beaks are so slightly developed as to give only a very moderate angulation to the cardinal extremity. The hinge-line is about one-third or one-fourth of the whole width, and the areas are, in general, concealed by the close approximation of the beaks when the valves are in place; but in separated valves the ventral area is well seen; that of the dorsal valve is linear. In the interior of the ventral valve the mesial septum extends only four lines from the beak in a specimen thirty lines in length; the triangular chamber is apparently two lines in length. In the dorsal valve the socket plates are very short, and not united: they have, as yet, only been seen by grinding down the beak. The small specimens are smooth, or only exhibit faint indications of ribs; but as the shell increases in size the ribs become stronger, although in some of the larger (as in the one figured) they are not very distinct. In general there are three or four obscure ribs running straight from the beak to the front; but on each side of these they curve outwards to the sides. The ribs are faintly developed, and there are from three to five in the width of three lines at the margin. There are also fine concentric wrinkles, not, however, always visible.

"Length of large individuals, three inches; width, varying from nearly equal to one-fifth less than the length. They occur of all sizes from a length of three fourths of an inch to three inches."

In nearly all the specimens from Anticosti the surface has a smoothish aspect, although the ribs are always more or less distinctly indicated. Those from the mainland are more strongly ribbed.

A number of specimens have been collected in Anticosti with scarcely any linguiform projection in the front margin. They are of a smaller size than those figured, and may belong to a distinct species.

"*Stricklandinia Davidsonii* differs from *S. lens*, in being more narrowed in front, more strongly ribbed, and in having the area concealed when the valves are in their natural position. Notwithstanding the variable form of the shell, there are none, in a collection of nearly a hundred specimens, that could be considered specifically identical with any of those figured by Mr. Davidson in the 'Monograph,' pl. ix. figs. 14–21. But there is a dorsal valve from the Niagara limestone at Cabot's Head, Lake Huron, exceedingly like fig. 13. It is, however, quite distinct from *S. Davidsonii*, and I think from *S. lens* also.

"As before stated the large individuals often have the ribs strongly developed, and curved out to the sides. They thus closely resemble the figure of *S. lirata* in 'Sil. Syst.," pl. xxii, fig. 6. Indeed, I could very nearly re-produce that figure from some of our broken specimens. It is these that I thought could be identified with *S. lirata*. The small smooth ones I supposed to be *S. lens;* but, after seeing Mr. Davidson's figures, I re-examined the whole collection, and find that there is a gradual passage from the smooth to the strongly ribbed. The specimen figured (figs. 1–1*c*) is about as perfect as a fossil can be, and is a good example of an intermediate form.

This species is dedicated to THOMAS DAVIDSON, Esq., F.R.S., F.G.S., &c., author of numerous publications on the fossil Brachiopoda.

Locality and Formation.—"This species occurs at a number of localities around the coast of the Island of Anticosti, from Jupiter River to East Point. It is most abundant at South-west Point, where the specimen figured was collected. It is associated with *Strophomena rhomboidalis, S. pecten, S. antiquata, Leptæna transversalis, Orthis Davidsonii, Pentamerus, oblongus. Spirifera plicatella, Leptocœlia* (*Atrypa*) *hemispherica Atrypa reticularis,* and many others mostly new species. The rocks belong to the Anticosti group, division 3, a horizon which is very nearly, if not exactly, that of the Upper Llandovery rocks. It also abounds on the mainland at the Schickschock Mountains, on the south side of the St. Lawrence, about 250 miles easterly from Quebec. I have never seen a specimen from any other part of America."

Collector.—J. Richardson.

STRICKLANDINIA SALTERII. (Billings.)

Plate, 7, fig. 1.

Description.—"Shell transversely oval; width greater than the length; sides and front usually rounded, but often with an obscure linguiform extension. Hinge-line nearly as wide as the shell, straight and a little

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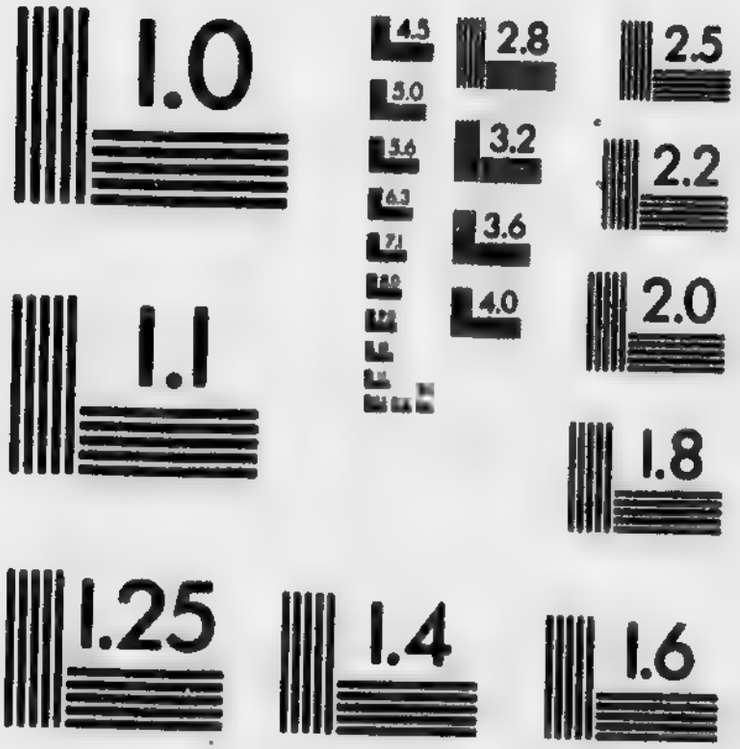

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sloping on each side of the beaks. Both valves are gently and uniformly convex. The ventral valve has often a barely perceptible mesial sinus; the umbo small; the beak not incurved; the area very narrow, scarcely exceeding the thickness of the shell; the foramen (as seen in detached fragments) triangular and open to the beak; the small chamber at the beak almost exactly like that of *S. lævis*, and *S. microcamerus*, as figured by Sowerby, M'Coy, and Davidson. The dorsal valve sometimes gives indications of an obscure mesial fold; but, in general, it is uniformly convex. I have not seen the area of this valve, but it must be linear; there is no umbo. Surface with several concentric imbrications of growth, and with very narrow obscure ribs, three or four in two lines, curving outwards to the sides, and some of them upwards to the hinge-line. These are also crossed by fine concentric wrinkles. When the specimens are slightly exfoliated all the surface-characters disappear.

"Length of the largest specimen seen, twenty-five lines; greatest width of the same, at about the mid-length, thirty-three lines. Some of the specimens indicate a greater proportional length.

"There is no other known species with which this need be compared except *S. lævis*, Sowerby, as described by M'Coy, under the name of *Pentamerus microcamerus* (Brit. Pal. Foss., p. 210). The width of that species, in proportion to the length, is stated to be as fifty-five is to one hundred, whereas in this it is, on an average, about eighty to one hundred. This great difference in proportions rarely occurs in the same species. Messrs. Davidson and Salter are of opinion that M'Coy's *P. microcamerus* is identical with *S. lens*. Be that as it may, the figure of *S. lævis*, given by Sowerby in 'Sil. Syst.,' pl. xxi., fig. 12, seems to be distinct from *S. lens*. and also from *S. Salterii*. He says (*Op. cit.*, p. 638), 'Semicircular, compressed, smooth; a slight elevation along the middle; beaks rather prominent, the area between them narrow, with parallel edges. Length, eight lines; width, twice as much.' The words 'elevation along the middle" could only apply to the dorsal valves of *S. lens* and *S. lævis*, in neither of which can the dorsal foramen be seen, when viewed in the position in which Sowerby's specimen is drawn, as it is in the figure cited. This figure, however, always appears to me to exhibit a sinus rather than a fold, in which case it would be a ventral valve. Judging from Mr. Davidson's figures, I should say that the upper part of the ventral valve of *S. lens* must be of a very different form from that of the specimen represented by Sowerby.

This species is dedicated to the late J. W. Salter, Esq., F.G.S., Palæontologist to the Geological Survey of Great Britain.

Locality and Formation.—*Stricklandinia Salterii* occurs at Heath

Point and Cormorant Point, Anticosti, in the Anticosti group, division 3 = to the Upper Llandovery rock.

Collector.—J. Richardson.

Stricklandinia Melissa. (N. sp.)

Pl. 7, figs. 4, 4*a*, 4*b*.

Description.—Moderately convex, truncate-ovate, greatest width about the mid-length; hinge-line straight, length about one-third less than the greatest width of the shell, cardinal angles about 90°; sides straight and nearly parallel for about two lines below the cardinal angles, then diverging with a gentle a curve to about the mid-length, thence converging with a moderate curve to the middle of the front margin, which is obtusely pointed. Area of the ventral valve slightly concave, inclining outwards at an angle of about 45°. Area of dorsal valve incurved over that of the ventral and almost in contact therewith. Beaks and umbones scarcely perceptible.

The surface is smooth with some obscure ribs towards the front margin. Both valves are about equally convex. Length of the specimen, twenty lines; greatest width, fourteen lines; length of the hinge-line, twelve lines; height of the ventral area, one line; depth of both valves about seven lines.

The above description is founded altogether upon a single specimen, which is, apparently, a good deal worn on the surface and somewhat distorted by pressure. No doubt, when more perfect ones shall have been discovered, some modification will become necessary. This species is widely different from all the Canadian form of the genus, except *S. Salterii*, from which it differs in its greater proportional length.

Locality and Formation.—South-west Point, Anticosti; Middle Silurian.

Collector.—J. Richardson.

In the first volume of this work, p. 85, two other species, from the Quebec group, are referred to this genus, (*S. Arachne* and *S. Arethusa;*) I think, however, that when more is known about them they will be otherwise classified.

4.—*Notes on the Structure of the Crinoidea, Cystidea and Blastoidea.**

The following Notes were published in the American Journal of Science and Arts, (2) vol. 48, July, 1869; vol. 49, Jan., 1870, and vol. 50, Sept., 1870:—in the Annals of Natural History, vol. 5, 1870, and vol. 7, 1871.

At the time when these notes were published, the single aperture in the summit of the palæozoic Crinoids was generally understood to be the mouth. But since then an important change has taken place in the views of most palæontologists who have studied the subject. The prevailing opinion at present is, that the aperture in question is the anus, and that what I call the ambulacral orifices, are the oral apertures. If this new view be correct, then, of course, my reasoning in the following note must fail altogether. But as I still maintain that the aperture is the mouth, I shall make no alteration, but reproduce these notes as originally published. I shall make some corrections and additions at the conclusion.

1. *Position of the mouth in relation to the ambulacral system.*

The earlier Paleontologists, Gyllenhal, Wahlenberg, Pander, Hisinger and others, described the large lateral aperture in the Cystidea as the mouth, apparently on account of its resemblance to the five-jawed oral apparatus of the sea-urchins. In his famous Monograph "Uber Cystideen," 1845, Leopold von Buch advocated the view, that it was not the mouth but an ovarian aperture; and that the smaller orifice usually situated in the apex, from which the ambulacral grooves radiate, was the true oral orifice. These opinions were adopted by Prof. E. Forbes in his Memoir on the British Cystidea, by Prof. J. Hall in the Paleontology of New York, and by most others who have described these fossils, including myself, in my first paper on the Cystidea of Canada, published in the Canadian Journal in 1854. In 1858 I re-investigated the subject while preparing my Decade No. 3, and came to the conclusions that the lateral aperture was the mouth, in those species which were provided with a separate anus; and that in all others it was both mouth and anus. The small apical orifice I described as an ambulacral aperture. According to these views, the mouth of a Cystidean does not stand in the centre of the radial system, as it does in all the existing Echinodermata. On this point Prof. Wyville Thompson has the following observations:

"I can see no probability whatever in the opinion lately advocated by

* In order to assist me in preparing these notes, S. S. Lyon, Esq., of Jeffersonville, Indiana, and Mr. Wachsmuth, of Burlington, Iowa, kindly lent me large collections of their beautiful Crinoids. Prof. E. J. Chapman, of Univ. Coll., Toronto, also supplied me with several Russian Cystideans. To all these gentlemen I here tender my thanks.

Mr. Billings, and which has received some vague support from the writings of De Koninck and others, that the 'pyramid' in the Cystideans is the mouth, and that the aperture whence the ambulacra radiate is simply an 'ambulacral orifice.' Such an idea appears to me to be contrary to every analogy in the class. There can be no doubt of the existence of distinct openings for the passage of the ambulacral nerves and vessels from the calyx of many of the paleozoic crinoids; but I think we must certainly assume that in this, as in all other known instances, these vessels had their origin in an annular vessel surrounding the mouth. In the whole class the æsophageal circular canal seems to be the origin and centre of the ambulacral system. It is the first part which makes its appearance in the embryo, and is so permanent and universal that one could scarcely imagine a radiating ambulacral vessel rising from any other source. The early origin of this important vascular centre, in this annular form and in this position, evidently depends upon, and is closely connected with, the origin of the nervous system in the æsophageal nerve ring, constant in the whole invertebrate series."*

With all due deference I cannot admit that we must assume that, in the Cystidea, the ambulacral tubes had their origin in "an annular vessel surrounding the mouth." It is true that such a vessel does surround the mouth of existing Echinodermata, but there is no essential or direct physiological connection between the two organs. Their functions are exercised independently of each other. There is no organ issuing out of the alimentary canal that communicates with the annular vessel. This latter might be situated in any other part of the body and still perform its functions, provided there were a connection between it and the ambulacral ring. In this class, the position of the various organs, in relation to each other, and also to the general mass of the body, is subject to very great fluctuations. Thus, the mouth and vent are separated in some of the groups, but united in others, while either, or both, may open out to the surface directly upward, or downward, or at any lateral point. The ovaries may be either dorsal or ventral, internal or external, and associated with either the mouth, the anus or with neither. The ambulacral skeleton may be imbedded into and form a portion of the general covering of the body or lie upon the surface, or borne upon free moving arms. In genera belonging to the same family these relations are constant, or nearly so, but are found to be extremely variable when different orders or when remotely allied families are compared.

While preparing my Decade No. 3, I investigated this subject and

* Edinburgh N. Phil. Jour., vol. xiii, p. 112, 1861.

satisfied myself that in, at least, a large proportion of the paleozoic Crinoids, the mouth was disconnected altogether from the radial system. A great many species might be referred to in which we can see both the centre, from which the ambulacra proceed, and the mouth; and at the same time see that they are not in the same place. A long train of reasoning is not necessary—only simple inspection. It will be quite sufficient to notice a few of these species to prove that the rule laid down by Prof. Wyville Thompson, is not a general rule.

Fig. 50.

Fig. 51.

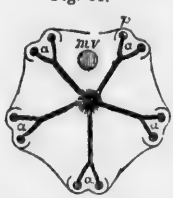

Fig. 52.

Fig.50.—This figure is a diagram of the interior of the vault of a Crinoid which appears to be *Batocrinus icosadactylus* (Cassiday), a fossil that occurs in the Carboniferous rocks of Kentucky. It was sent to me by Mr. S. S. Lyon, of Jeffersonville, Indiana, several years ago. The test is in a beautiful state of preservation and perfectly empty, so that all of the markings on the inner surface can be distinctly seen. There are twenty-one arms, arranged in five groups (*a*), and the same number of ambulacral openings (*p*), each just large enough to admit of the entrance of a slender pin. The mouth (*mv*) is nearly central, and close to it, on the posterior side, there is a small rudely pentagonal space (*c*) with no markings except several small tubercles The grooves are scarcely at all impressed, and, indeed, I think they never are so in any Crinoid, except in those which have a thick test. In this specimen their course is clearly indicated by the remains of the thin partitions which either separated them or to which the vessels were attached. They do not run directly toward the mouth, as they would do if that organ were the centre of the ambulacral system, but to the small space (*c*) behind it where there appears to have been situated a vesicle or some other apparatus, to which all of them were united. Whatever may have been the structure of this central organ, from which the five main grooves radiate, it no doubt represented the annular vessel of the recent Echinodermata to which Prof. Thompson alludes.

Fig.51.—represents the structure of an *Anphoracrinus* from the Carboniferous rocks of Ireland,—precise locality and species not determined.

There are ten arms; the test is very thick; the ambulacral channels converge to the central point (*c*) but do not quite reach it; the mouth (*mv*) is about half way between the center and the margin. In this Crinoid it is perfectly impossible that the mouth can be the centre of the radial system because the two anterior passages, between which it is situated, are for their whole length tunneled, as it were, through the substance of the plates, and only penetrate downward into the interior at the central space (*c*).

Fig. 52.

Fig. 52 —is a plan of the summit of the widely known and remarkable fossil *Caryocrinus ornatus* (Say). In this species there are only three, instead of five, groups of arms. In large individuals there are from twelve to twenty free arms (but always arranged in the three groups) with a small pore at the base of each. This pore is about the size of the ovarian pore of an *Echinus*, and can only be seen in well preserved and clean specimens. The ambulacral grooves have not yet been observed but their course is indicated by three low rounded ridges, which may be seen, in some specimens, radiating from a large heptagonal plate situated at (*c*). The mouth (*mv*) is valvular, composed of from five to eight or ten plates, and is always situated near the margin between the two anterior groups of arms. With the exception of the ambulacral pores there is positively no other aperture in the summit of *Caryocrinus*. If it be true that the mouth of an Echinoderm must be always situated in the radial centre, then *Caryocrinus* and also nearly all the paleozoic genera were destitute of that aperture.

Caryocrinus is a genus which seems to form a connecting link between the Crinoidea and the Cystidea. By examining numerous well polished sections I find that the structure of the respiratory areas is the same (in general plan) as that of the genera *Glyptocystites*, *Pleurocystites* and *Echinoencrinites*, as will be shown further on. The arms are also arranged in three groups as in *Sphæronites* and *Hemicosmites*, while the mouth is valvular. On the other hand, the long cylindrical column and the arrangement of the arms around the margin, with the ambulacral pores at their bases, are crinoidal characters.

In addition to the above, the following species may be referred to, as examples of Crinoids with the mouth separate from the centre of the radial system.

Amphoracrinus tesselatus (Phillips).—Figured by J. Rofe, Esqr. Geol. Mag., vol. ii, p. 8, f. 3. The figure represents a cast of the interior of the vault showing the five ambulacral grooves in relief. The mouth is situated in the angle between the two anterior grooves.

Strotocrinus perumbrosus (Hall, sp.).—Figured by Meek and Worthen

in the Geology of Illinois, vol. ii, p. 188, fig. 5. The specimen is thirteen lines in diameter, the ambulacral centre thirteen lines from the anterior margin, and the mouth eleven lines. *

Glyptocrinus armosus (McChesney, sp.).—This extraordinary Crinoid is figured by McChesney in his "New Pal. Foss.", pl. 7, f. 6, and also by Prof. Hall, in the 20th Reg. Rep., N.Y., pl. 10, f. 11. The specimens are between two and three inches in length. There are ten arms, the anterior side is much inflated, the proboscis appears to be large at its base and excentric in its position, but instead of standing erect, it bends down to the surface of the vault, and lies upon it, crossing over to the posterior margin. Judging from the figures, the centre of the base of this organ must be distant from the radial centre at least one-fourth of the whole width of the vault. *G. Siphonatus* (Hall), figured on the same plate, shows, that the anterior grooves curve round to the posterior side of the proboscis, as they do in *B. icosadactylus* above cited.

I should also state here that two or three years ago, Mr. Meek, to whom I had written for information on this subject, wrote me that in all cases, where he had observed the grooves on the interior of the vault, they radiated, not from the mouth, but from a point "in front of it." (This would be not in front of, but behind the mouth, according to the terminology used in these notes. I think that the side in which the mouth is situated should be called "anterior" or "oral," even although both the mouth and anus should be included in it.)

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* In April last I received from Messrs. Meek and Worthen a paper entitled, "Notes on some points in the structure and habits of the Paleozoic Crinoidea." Of all the papers relating to this subject yet published on this continent, this one, at least so it appears to me, is the most interesting and important. It is written with a clearness and particularity rarely to be seen in paleontological memoirs. In some respects it confirms the opinions advocated in these notes, but bears directly against my views on the question here under discussion, i.e.—"the position of the mouth with relation to the radial center." As I wish to give the remarkable observations of the authors full consideration, I shall not discuss them now but delay until the September No. of this Journal. I shall only state here, that I believe that the grooves on the ventral disc of *Cyathocrinus*, and, also, the internal "*convoluted plate*" of the Paleozoic Crinoids, with the tubes radiating thereform, belongto the respiratory and, perhaps, in part, to the circulatory systems—not to the digestive system as is supposed by the authors. The convoluted plate with its thickened border, seems to forshadow the "œsophageal circular canal" with a pendant madreporic apparatus as in the Holothuridea. To me the final determination of this question is of much importance, for, if Meek and Worthen are right, then I must be wrong so far as regards nearly all that I have published with reference to the functions of the apertures of the Paleozoic Echinodermata. It is fortunate that the solution of this curious problem is now undertaken by men who have access to the magnificent cabinets of the geologists of the western States, and also by men who habitually discuss scientific subjects with the sole object in view of arriving at the truth.

In all the species above cited, the figures (with the exception of *C. ornatus*) exhibit the relative position of the mouth and radial centre, as it has been actually seen in casts of the interior of the vault. But besides these, numerous examples may be found in the works of Miller, Austin, De Koninck, Phillips, Meek, Worthen, Shumard, Hall, Lyon, Cassaday and others, of Crinoids whose external characters show that, in them, the mouth cannot be in the central point from which the grooves radiate.

With respect to Prof. Thompson's theory, I freely admit that if it is true that in all the Echinodermata, fossil and recent, the mouth is the radial centre, then, that aperture must be the one which I call the ambulacral orifice in the Cystidea. The views, however, advocated by me in my Decade No. 8, appear to be gradually gaining ground. As these fossils are rare, few have occasion to study them, and consequently the subject has not been much discussed since 1858, the date of the publication of that work. The following are the only authors, so far as I have ascertained, who have given their opinions on this vexed question during the last eleven years:—

Prof. Wyville Thompson, op. cit., p. 111 (1861), agrees with me that the lateral aperture is not an ovarian orifice, but, as we have seen, is strongly opposed to the view that it is the mouth. He calls it the anus.

Prof. Dana (Man. Geol., p. 162, 1863) recognizes it as the homologue of the simple aperture (oral and anal) in the summit of those Crinoids which have but one. This is exactly my view. [J. W. Salter agrees with Prof. Thompson that it is the anus, not the ovarian aperture. (Mem. Geol. Sur. G. B., vol., iii, p. 286, 1866.) Prof. S. Loven of Stockholm has described, in the "Proceedings of the Royal Swedish Academy," 1867, the remarkable sea-urchin, *Leskia mirabilis* (Gray), which has the mouth constructed on the same plan as that of the Cystidea, that is to say, with five triangular valve-like plates, which are immediately attached to the interambulacral valve-like plates, without the intervention of a baccal membrane. After comparing this structure with the valvular orifice of *Sphæronites pomum* (Gyll.) he says "that the 'pyramid,' which in *Leskia* is the armature and covering of the mouth, is the same thing in the *Cystidea* is now quite certain; in the last-named group it was, doubtless, also the vent. The mouth does not lie where J. Muller and Volborth sought for it, viz: in the centre of the ambulacral furrows; and the organ, interpreted as the vent by Volborth and von Buch, is more correctly regarded as an external sexual organ." Geol. Mag., vol. v, p. 181, Dr. Lutken's trans.]

2. *On the pectinated rhombs and calycine pores of the Cystidea.*

None of the organs of the Echinodermata have been the subject of so much speculation as the calycine pores and the so-called "pectinated rhombs" of the Cystidea. Their relations and function long remained in doubt, but there seems to be, now, sufficient data to show that they are respiratory organs, and also, that they are the homologues of the tubular apparatus which underlies the ambulacra of the Blastoidea. J. Muller suggested a comparison between these peculiar organs and the respiratory pores of the *Asteridæ*. (Uber den bau der Echinodermen, p. 63, 1853.) Prof. Huxley has placed them in the same relation. (Medical Times, Dec., 1856.) Eichwald calls them respiratory pores. (Lethaea Rossica, vol. 1, p. 614, 1860.) Prof. Dana says "they are probably connected with an aquiferous system and respiration." (Man. Geol., p. 162, 1863.) Mr. Rofe, after showing that their structure is the same as that of the striated surfaces between the rays of *Codaster*, says, "from the construction of these striations on the face of *Codaster*, and on the 'pectinated rhombs' of the cystidea, may we without assumption suggest the possibility of their being respiratory sacs, lined with cilia, and constructed of a porous test, through which air from the water could pass by diffusion." (Geol. Mag., vol. ii, 251, 1865.) As for myself, when I prepared my decade on the cystidea, I gave this subject a great deal of consideration, and studied a large number of specimens, but could arrive at no conclusion satisfactory to myself. I am now convinced that the view of the above named distinguished authors is the correct one. These are respiratory organs. In all the species in which they occur, they seem to be constructed on the same general plan, i. e., the interposition of an exceedingly thin partition, between the circumambient water, and the fluid within the general cavity of the body. They are usually of a rhomboidal shape—each rhomb being divided into two triangles by the suture (*c*, *c*, figs. 53, 54,) between two of the plates. In several of the genera the two halves of the hydrospires are reniform, ovate or lunate, and either internal or external.

In order to avoid the use of double terms, I propose to call them "*hydrospires*," and their apertures, "*pores*," "*fissures*," or "*spiracles*" according to their form.

In Caryocrinus ornatus the hydrospires (fig. 53,) are of a rhomboidal form, and have each of the four sides bordered by a single row of small tubercles. Some of these tubercles have a single pore in the summit, while others are perforated with a variable number,—from two to twenty, or perhaps more,—thus becoming vesicular or spongy. It is only the apex of the tubercle, however, that has this structure, for, when this is

worn off, there is only a single pore to be seen. The pores penetrate through the plates but do not communicate directly with the general cavity of the body. Internally each hydrospire consists of a number of flat tubes arranged parallel to each other and lying side by side, in the direction of the dotted lines in fig. 53, *a*. Each tube receives two of the pores seen on the exterior—one pore at each end. These tubes are composed of a very thin shelly membrane, which, although possessed of sufficient rigidity to maintain its form, was no doubt of such a minutely porous texture as to admit of the transfusion of fluids in both directions, outward and inward. In a large hydrospire there are about twenty of those tubes. Their greatest breadth is at their mid-length where they are crossed by the suture *c*, *c*; and as they become narrower accordingly as their length decreases, the one in the middle projects the deepest into the perivisceral cavity. In consequence of this arrangement when a section is made across the hydrospire at the suture *c*, *c*, fig. 53 *a*, the form *b*, is obtained where *c*, *c*, is the surface of the shell, while the comb-like structure below represents the tubes.

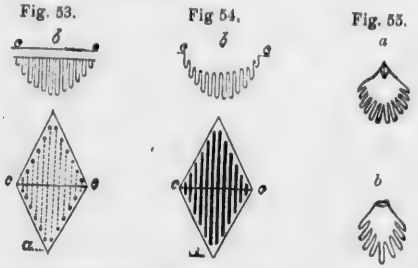


Fig. 53 Hydrospire of *Caryocrinus ornatus*. *a*, surface view, the dots around th e margin are the spiracles, the small dotted lines represent the course of the flat internal canals *c*, *c*, suture between the two plates; *b*, transverse section. Fig. 54. Hydrospire of *Pleurocystites*. *a*, surface view; *c*, *c*, suture; *b*, tranverse section. Fig. 55 *a*. The same with the points *c*, *c*, drawn together; *b*, internal gill of a spider.

Specimens of *C. ornatus* almost entirely empty are often found, and in some of these the internal form of the hydrospires is sometimes preserved. Those that I have seen have the form of small rhomboidal pyramids, with four slightly convex sloping faces, and composed of a number of vertical parallel plates—the casts of the interior of the tubes—the substance of the tube itself not being preserved. I have, however, several polished tranverse sections, in which I think the thin walls can be seen.

The structure of the hydrospires is such, that there can scarcely be any doubt that they are respiratory organs. The sea-water entered throughthe pores, and ærated the chylaqueous fluid, contained in the

perivisceral cavity, by transfusion through the exceedingly thin membranous shell, that composed the walls of the tubes. The number of pores varies with the size of the individual. In large specimens these are from 800 to 1000.

It has been stated by some authors that the pores were passages for the protrusion of internal organs connected with the vitality of the animal. The fact, however, that the pores do not penetrate into the general cavity of the body disproves this theory; and, moreover, through many of the tubercles—those with a vesicular and spongy summit, such protrusion would be utterly impossible.

In *Caryocrinus ornatus* there are thirty hydrospires arranged as follows:

1. Ten at the base—half of each on a basal plate and the other half on one of the subradials, their longer diagonal vertical.

2. A zone of six around the fossil at the mid-height—their longer diagonals horizontal. These seem to be imperfectly developed, for, on the inside, the tubes occupy only a small space in the center.

3. A third band of fourteen—two of them with their longer diagonals vertical and the others arranged in six pairs, the diagonals of each pair inclining toward each other, upward, at an angle of about 30°. There are only three interradii in *Coryocrinus;* the mouth is placed in one of them and the two hydrospires with vertical diagonals in the other two.

In *Pleurocystites* the hydrospires are also of a rhomboidal form, but instead of having the tubular structure of *Caryocrinus*, they consist of a number of parallel inward folds of an exceedingly thin part of the shell. These folds no doubt represent the tubes of *Caryocrinus*. If we grind down a hydrospire of this latter, so as to remove all the shell, and expose the edges of the tubes, it then exhibits precisely the same form as fig. 54 *a*, i. e., the form of a rhomb, longitudinally striated at right angles to the suture, and with no pores. The transverse section in *Pleurocystites* only differs from that in *Caryocrinus* in having no shell between the points *c, c*. In the hydrospire of *Pleurocystites robustus*, of the Trenton limestone, we have the commencement of the formation of an internal gill with a single spiracle. The surface is not flat, as it is in many species, but concave as shown in the section; and it is evident that if the concavity should be carried further, and at the same time the points *c*, *c*, made to approach each other, the effect would be to produce an elongated sack, deeply folded on one side, and with a fissure extending the whole length on the other side. The transverse section of such a sack would be fig. 55, the same as in *Pentremites*. Again, if we contract the four sides, gradually curving them outward at the same time, but not diminishing the

superficial extent of the walls of the folds although altering the form to correspond with the decreasing aperture, the result would be a deeply folded, flask-shaped sack, with a small round orifice like fig. 55*a*, which is the internal gill of a spider.

In *Palæocystites tenuiradiatus*, a species very characteristic of the Chazy limestone, the whole surface (in the condition in which the fossil is usually found) is covered with deeply striated rhombs, the fissures being deepest where they cross the suture and growing gradually shallower as they approach the centre of the plates, where they die out altogether. Detached plates occur in vast abundance, but no perfect specimens have ever been found. I discovered, however, several fragments of the body sufficient to give the general form and to show that, when the surface in perfect, all these fissures are completely covered over by a very thin shell, and that, where they cross the suture there is a small pore in the bottom of each which penetrates to the interior. The rhombs of this species are thus external hydrospires. The fissures seen in the ordinary weathered specimens are the remains of flat tubes like those of *Caryocrinus*, situated on the outer instead of the inner surface of the test. The chylaqueous fluid passed outward through the pores and filled the tubes, to be ærated through the thin external covering by the surrounding water. In *Caryocrinus* the water passed inward, through the pores, into the tubes and ærated the fluid within the general cavity of the body.

The discovery that the fissures and pores of the Cystidea do not communicate directly with the general cavity of the body is entirely due to Mr. Rofe. After reading his highly important paper, I re-examined a great number of specimens and found sufficient to confirm his observations.

3. *On the genus Codaster.*

Every author who has described a species of this genus has remarked the peculiar striated areas in the interradial spaces. Prof. McCoy, the founder of the genus, pointed out their resemblance to the hydrospires of the Cystidea, but it was Mr. Rofe who first showed that they were also identical in structure therewith. On comparing one of those with that of the cystidean *Pleurocystites*, fig. 54, we at once perceive that they are the same in the external form while Mr. Rofe's figures show that the section 56 *d*, *d*, has the structure of fig. 57, which only differs from fig. 54 *b*, in being straight above instead of concave, and in being divided into two parts. This division is the result of the position of the arm which cuts the hydrospire in two, in a direction parallel to the fissures. By

drawing the points *d*, *a* and *a*, *d*, together we get figure 59, which is in general plan, a section across one of the ambulacra of a Pentremite. On examining nearly all the published figures of species of this genus I find that there is a series of forms which exhibit a gradual passage, from those with the hydrospires almost entirely exposed, as in fig. 56, through others in which they are crowded more and more under the arms, until at length they become altogether internal.

Fig. 56

Fig. 57

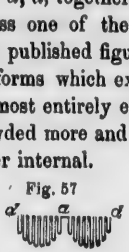


Fig. 58

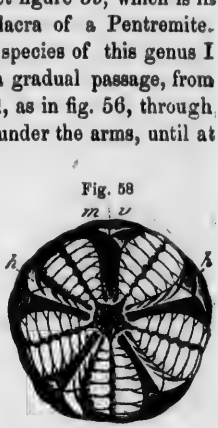


Fig. 59

Fig. 56. Summit of *C. acutus* McCoy, *m*, *v*, mouth and vent; *d*, *d*, suture across the posterior hydrospire. 57. Section across the hydrospire from *d*, to *d*, at *a*, is the place of the arm. 59. Section contracted as in fig. 58. . Summit of *Pentremites caryophyllatus* De Koninck.

In *C. acutus*, fig. 56, only a small portion of the hydrospire is concealed under the arm. In *C. Canadensis*, a new species lately discovered in the shales of the Hamilton group in Canada West, each of the four interradial spaces, in which the hydrospires are placed, is excavated, in such a manner as to form *a small triangular pyramid*, with two of its faces sloping down toward the sides of the two adjacent arms. On these two slopes are placed the hydrospires, which appear to have one fissure entirely under, and another partly under the arm, five others being fully exposed. S. S. Lyon has described a species under the name of *C. alternatus* in the "Geology of Kentucky,' 'vol. iii., p. 494, from the Devonian rocks of that State, which closely resembles *C. Canadensis*, but is still distinct thereform. Speaking of the structure of the summit he says: "the depressed triangular intervening spaces are filled with seven or more thin pieces, lying parallel to the pseudambulacral fields, articulating with the summit of the second radial, and the prominent ridge lying between the pseudambulacræ. These pieces were evidently capable of being compressed or depressed: the '*point*' at the lateral junction of the second radials is in some specimens folded over toward the mouth so as to entirely obscure these triangular spaces by covering them." This important observation proves that even in the same species the hydrospires may be either partly or wholly concealed under the arm. The "*point*" to which

Mr. Lyon alludes is seen above, in fig. 58 just below the letter *h*. It is the same as the "*small triangular pyramid*" in *C. Canadensis*. It is evident that (supposing the shell to be flexible) if these points were to be drawn inward, the movement would gradually cause what remains exposed of the hydrospire to be covered until at length it would be entirely concealed under the arm. The five points would then be situated in the angles between the five ambulacra as they are in the genus *Pentremites*, fig. 63. The concealment of the hydrospires may also be the result of the widening of the arm. This is well shown in *P. caryophyllitus* De Koninck, (*P. Orbignyanus* according to Roemer,) *P. Schultzii* De Ver., and several other species. In these the apices of the pyramids remain near the margin, but the hydrospires are nearly covered by the wide arms. This is shown in fig. 58, where the ends of the fissures of the hydrospires are seen along the sides of the angular ridges which extend from the apices of the pyramids to the angles between the arms. I do not think that such species can be referred to *Pentremites*, and if I had specimens before me instead of figures only, I would most probably institute a new genus for their reception.

Our specimens of *C. Canadensis* are well preserved and show the characters of the arms perfectly. After many careful examinations under the microscope, I can state positively that in this species the so-called "pseudambulacral fields" have no pores. The markings that have hitherto been mistaken for ambulacral pores in *Codaster* are not pores, but the small pits or sockets which received the bases of the pinnulæ. The rays therefore in this genus are not "pseudambulacral fields," in the sense in which that term is used in descriptions of species of *Pentremites*, but simply recumbent arms, identical in structure with those of the cystidean genera *Glyptocystites*, *Callocystites*, *Apiocystites*, and others. They lie upon the surface of the plates which constitute the shell of the animals, not imbedded into them as in *Pentremites*. The large lateral aperture is both mouth and vent, and the central opening heretofore called the mouth is the ambulacral or more properly, the ovarian orifice. As, therefore, *Codaster* has the arms of *Apiocystites*, the hydrospires of *Pleurocystites* and the confluent mouth and vent common to all *Cystideans*, I propose to remove it from the *Blastoidea* and place it in the order *Cystidea*.

4. *On the genus Pentremites.*

In *Pentremites* the hydrospire is an elongated, internal sac, one side of which is attached to the inside of the shell, while the side opposite, or

toward the central axis of the visceral cavity, is more or less deeply folded longitudinally. There are two of these to each ambulacrum, attached along the two lines of pores. There appears to be a fissure extending nearly the whole length in the direction of the dotted line *f*. One edge

Fig.60

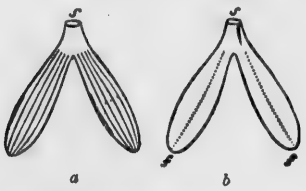


Fig. 61

Fig.62

Fig. 63

Fig. 60.—Diagrams of one pair of the hydrospires of a *Pentremite*,—*a*, the inner side; *b*, the outer, or side attached to the shell; *f*, the fissure. 61. Section across an ambulacrum of a specimen of *P. Godoni*, enlarged 3 diameters.—*l*, lancet plate; *g*, ambulacral groove; *p*, *p*, pores leading into the hydrospires; *h*, *h*, the two hydrospires, in transverse section. 62. Ideal figures of a transverse section through an entire specimen showing the ten hydrospires,—*l*, one of the five lancet plates; *p*, *p*, pores; *r*, *r*, the two branches of one of the radial plates. 63. Summit of *P. conoideus*,—*a*, anterior side; *g*, ambulacral grooves (copied from Dr. Shumard, but with the ovarian pores added).

of this fissure, is attached to the lancet plate, along one side of the line of pores; the other to the shell, on the other side of the row. The pores all enter the hydrospire through this fissure. There are ten hydrospires, connected together in pairs, each pair communicating with the exterior through a single spiracle. The arrangement of the folds varies according to the species. In *P. Godoni* there are five folds, the outer sides of which are close up to the inner side of the lancet plate, fig. 6I. In a specimen of *P. obesus* Lyon, nearly two inches in diameter at the mid-height, the hydrospires extend inward about three lines, the main body being about one line from the lancet plate. There are five folds, each two lines deep;

and thus, if the thin shelly membrane, which constitutes the wall of the hydrospire, were spread out, it would have a width of 22 lines,—and the ten together would form a riband, about 18 inches in length, and nearly two lines wide. The object of the folding is, of course, to confine this large amount of surface to a small space, an arrangement which at once proves the function to be respiratory. Of those figured by Mr. Rofe *P. ellipticus* Sowerby appears to have only one fold, *P. inflatus*, id., shows eight folds in one, and eleven in the other hydrospire of the same ambulacrum. Another specimen figured by Mr. Rofe under the name of P. *florealis* Say, has five folds situated at a distance from the inner surface of the lancet plate as in *P. obesus*. From the form of the organ I think that Mr. Rofe's specimen cannot be the species called P. *florealis* by Say.

If it be granted that these organs are respiratory in their function, then, their five apertures should be called *spiracles*,—not "ovarian orifices." The large anterior aperture would thus be the *oro-anal spiracle*. Applying this system of terminology to other groups,—the so-called ovarian orifice of the Cystidea, the homologous aperture of *Nucleocrinus*, *Codaster*, *Granatocrinus* and of the Paleozoic Crinoidea generally (but not of the recent forms), should be styled the *oro-anal orifice*.

I think that the side of an Echinoderm in which the mouth is situated should be called "anterior" even although the anus and the mouth be confluent in one orifice. Most star-fishes have but one aperture for mouth and vent, and yet it is called the mouth by naturalists generally. Why not call the underside of a star-fish "the anal or posterior side," and the central aperture the "anus?"

Dr. B. F. Shumard has shown (Trans. Acad. Nat. Sci. St. Louis, vol. 1, p. 243, pl. 9, fig. 4,) that in perfect specimens of *P. conoideus* Hall, the six summit apertures are closed by several small plates. In a specimen of the same species sent me by Mr. Lyon, in which those plates are partly preserved, I find that there is a small pore in each of the five angles of the central aperture. The five ambulacral grooves enter the interior through these pores. I have copied his figure but modified it by adding the pores, fig. 63. He also found that the summit of *P. sulcatus*, Roemer, was covered with an integument of small plates arranged in the form of a pyramid. From these facts he infers that in all the *Pentremites* the summit apertures will be found, in perfect specimens, to be closed in a similar manner.

5. *On the homologies of the respiratory organs of the Palæozoic and recent Echinoderms, and on the "Convoluted Plate" of the Crinoidea.*

In a former note I have advanced the opinion that:—"The grooves on

the ventral disc of *Cyathocrinus* and, also, the internal '*convoluted plate*' of the Palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory and, perhaps, in part, to the circulatory systems—not to the digestive system. The convoluted plate with its thickened border seems to fore-shadow the 'œsophageal circular canal' with a pendant madreporic apparatus as in the Holothuridea." I should have referred it it to the madreporic system of the existing Echinodermata in general, instead of to that of the Holothuridea in particular. At the time the note was written I had in view the madreporic sack of *Holothuria* which, as will be shown further on, most resembles in form that of *Actinocrinus*. The figures and descriptions, which follow, are intended to show the gradual passage or conversion of the respiratory organs of the *Cystidea*, *Blastoidea* and *Palæocrinoidea* into the ambulacral canal system of the recent echinoderms, and that as the convoluted plates of the former have the same structure and connections as the madreporic sacks and tubes or sand canals of the latter, they are, most probably, all the homologues of each other.

Among the Cystideans we find several genera, such as *Cryptocrinites*, *Malocystites*, *Trochocystites*, and apparently some others, whose test is totally destitute of respiratory pores, being composed of simple, solid plates like those of the ordinary Crinoidea. In a second group of genera, among which may be enumerated *Caryocystites*, *Echinosphærites*, *Palæocystites and Protocystites*, the whole of the external integument seems to have been respiratory, as all, or nearly all of the plates of which it is composed, are more or less occupied by variously arranged, poriferous or tubular structures. The Cystideans of these two groups hold the lowest rank of all those known. In their general structure they are mere sacks of a globular, ovate or, (as in case of *Trochocystites*) flattened form. Their test consists of an indefinite number of plates without any radiated

Fig. 64,

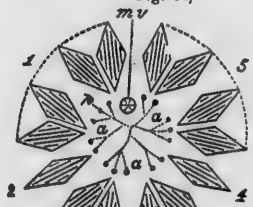


Fig. 65,

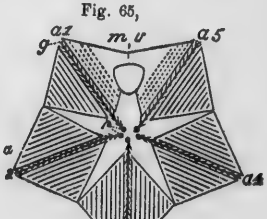


Fig. 66,

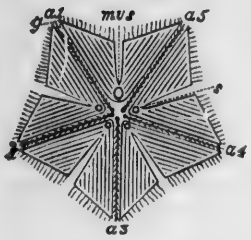


Fig. 67,

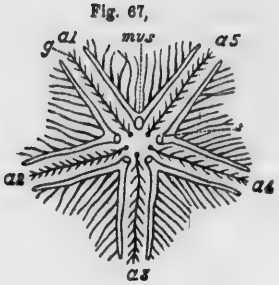


Fig. 68,

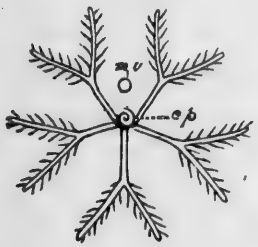


Fig. 69,

Fig. 70,

Fig. 64. The upper part of *Caryocrinus ornatus*, the test being removed in order to show the internal structure of the fourteen hydrospires that surround the summit. The parallel lines represent the flat tubes. The other figures exhibit the modifications which the hydrospires undergo in passing through: 65. *Codaster*. 66. *Pentremites* with broad ambulacra. 67. *Pentremites* with single tubes. 68. *Palæozoic Crinoids* with a convoluted plate attached to the centre of radiation. 69. Sand canal or madreporic tube of a starfish inclosing a doubly convoluted plate. 70. Ambulacral canals of a starfish with the doubly convoluted plate of the sand canal attached to the œsophageal ring. The following letters have the same reference in all the figures in which they occur: *a*, an arm or ambulacrum; *m v*, mouth and vent combined in a single aperture; *m v s*, mouth, vent and spiracle; *g*, ambulacral groove; *p*, ovarian pore; *s*, spiracle; *o p*, convoluted plate; *r*, œsophageal ring.

arrangement. They were also, according to our present knowledge, the first to make their appearance, two of the genera, *Trochocystites* and *Eocystites*, having been discovered in the primordial zone. No other echinoderms have been found in rocks of so ancient a date.

Next in order may be placed those genera whose test is composed of a definite number of plates, which have, to some extent, a quinary arrangement. Thus, *Glyptocystites*, *Echinoencrinites*, *Apiocystites* and several others, have each four series of calycine plates, of which there are four plates in the basil and five in each of the other three series. The respiratory areas or hydrospires are reduced in number—ten to thirteen in *Glyp-*

tocystites and three in most of the other genera of the group. Neither in the plates nor in the hydrospires is there exhibited any tendency to a radiated arrangement. The most ancient genus of this family is *Glyptocystites*, which first appears in the Chazy limestones and seems to have become extinct in the Trenton. The other genera occur in various horizons between the Chazy and the Devonian.

In the genera *Hemicosmites* and *Caryocrinus* the hydrospires in the upper part of the test converge toward, but do not reach, the central point of the apex, thus forming the commencement of that concentration and complete radiation which is exhibited in the ambulacral canal system of the higher echinoderms. In a former note (ante p. 98) it is pointed out that *Caryocrinus* has thirty hydrospires—ten at the base with their longer diagonals vertical,—a zone of six round the middle with their diagonals horizontal, and a third band of fourteen around the upper part of the fossil. These latter are represented in fig. 64, as if spread out on a plane surface. On consulting this figure it will be seen that the flat tubes of the hydrospires, represented by the parallel lines, all converge toward the central point from which the dotted lines radiate. This point is the position of the mouth in the recent echinoderms, but in *Caryocrinus* it is occupied by a large solid imperforate plate. The hydrospires are arranged in five groups. Commencing at *m v* and going round by 1, 2, &c., there are four in the first group; one in the second; four in the third; one in the fourth and four in the fifth. These five groups represent the five ambulacral canals of the recent echinoderms. In the specimen from which this diagram was constructed there are the bases of fifteen free arms to be seen situated at the outer extremities of the dotted lines. At the base of each arm there is a small pore, *p*, which I believe to have been exclusively ovarian in its functions. The hydrospires have no connection whatever with the arms, and are, moreover, all of them entirely separated from each other. If then they represent the ambulacral system of the recent echinoderms, it is quite certain that that system was at first, (or in the undeveloped stage in which it existed in the Cystidea,) destitute of the œsophageal ring.

In *Codaster* a further concentration of the respiratory organs is exhibited. There are here only five hydrospires, and they are all confined to the circle around the apex. Two of them are incomplete in order to make room for the large mouth and vent (*m v*, 65.) They are each divided into two halves by an arm, *a*1, *a*2, &c. They are only connected with the arms to this extent, that these latter lie back upon them. The arms are provided with pinnulæ, but it is not at all certain that they (the pinnulæ) were in any direct communication with the hydrospires. It is evident

that in all the Cystidea, (and in none is it more obvious than in *Caryocrinus*), there was no connection between the hydrospires and the pinnulæ. The main difference (so far as regards the evidence of the presence or absence of such a connection) between *Caryocrinus* and *Codaster*, consists in this, that in the former the arms are erect and do not touch the hydrospires, whereas in the latter they are recumbent and lie back upon them. Each of the arms of *Codaster* has a fine ambulacral groove, and all of the grooves terminate in a single central aperture. But as this aperture was covered over by a thin plated integument, as in the Blastoidea, I have not shown it in the diagram, but only the five pores, *p*.

No one who compares a *Codaster* with a *Pentremites* (the internal structure of the latter being visible) can doubt that the hydrospires of the two genera are perfectly homologous organs. If we grind off the test of a species of the latter genus, selecting one for the purpose which has broad petaloid ambulacra such as those o *p. Schultzii*, the structure exposed will be that represented in the diagram, fig. 66. In *Pentremites*, as in *Codaster*, the five hydrospires are divided into ten equal parts by the five rays, *a*1, *a*2, &c. In *Codaster* these ten parts remain entirely separate from each other, but in *Pentremites* they are re-united in pairs, the two in each interradial space being so connected, at their inner angles, that their internal cavities open out to the exterior through a single orifice or spiracle (*s* figs. 66and 67). This is best shown in fig. 67 intended to represent the structure of *P. ellepticus* (Sowerby) as described by Mr. Rofe, Geol. Mag., vol. ii, p. 249. In this species the hydrospires instead of being formed of broad sacks, with a number of folds on one side, consists of ten simple cylindrical tubes connected together in five pairs. The only difference between the structure of fig. 66 and fig. 67 is in the width of the tubes and in the absence of folds in the latter. These two forms are moreover connected by intermediate grades. Species with 11, 10, 8, 6, 5, 4 and 2 folds being known, there is thus established a gradual transition from the broad petaloid form to the single cylindrical tube.

Between the *Cystidea* and the *Blastoidea* the most important changes are, that in the latter the hydrospires become connected in pairs, and also are brought into direct communication with the pinnulæ. In the Palæozoic Crinoidea (or at least in many of them) concentration is carried one step further forward, the five pairs of hydrospires being here all connected together at the centre as in fig. 68. There is as yet no œsophageal ring (as I understand it), but in its place the convoluted plate described in the excellent papers of Messrs. Meek and Worthen. This organ, according to the authors, consists of a convoluted plate, resembling in form the shell of a *Bulla* or *Scophander*. It is situated within the body

of the Crinoid with its longer axis vertical and the upper end just under the centre of the ventral disc. Its lower extremity approaches but does not quite touch the bottom of the visceral cavity. Its walls are composed of minute polygonal plates or of an extremely delicate network of anastomosing fibres. The five ambulacral canals are attached to the upper extremity, radiate outward to the walls of the cup and are seen to pass through the ambulacral orifices outward into the grooves of the arms. (Am. Jour. Sci. vol. xlviii, p. 31.)

The ambulacral canals of the Crinoidea are, for the greater part, respiratory in their function. They are, however, as most naturalists who have studied their structure will admit, truly the homologues of those of the Echinodermata in general. In the higher orders of this class the canals are usually more specialized than they are in the lower; being provided with prehensive or locomotive organs. In all of the existing orders, including the recent Crinoidea,? we find an œsophageal ring.

To this organ, which is only a continuation of the canals, are attached the madreporic appendages. These consist of small sacks or slender tubes varying greatly in form and number in the different genera. That of the Starfish *Asteracanthion rubens* is thus described by Prof. E. Forbes. "On the dorsal surface is seen a wart-like striated body placed laterally between two of the rays: this is the *madreporiform tubercle or nucleus*. When the animal is cut open, there is seen a curved calcareous column running obliquely from the tubercle to the plates surrounding the mouth; Dr. Sharpey says it opens by a narrow orifice into the circular vessel. It is connected by a membrane with one side of the animal, and is itself invested with a pretty strong skin, which is covered with vibratile cilia. Its form is that of a plate rolled in at the margins till they meet. It feels gritty as if full of sand. When we examine it with the microscope we find it to consist of minute calcareous plates, which are united into plates or joints, so that when the investing membrane is removed it has the appearance of a jointed column. Professor Ehrenberg remarked the former structure, Dr. Sharpey the latter: they are both right. Both structures may be seen in the column of the common cross-fish." (Forbes, British Starfishes, p. 73.)

In Prof. Joh. Muller's work, "Uber den bau der Echinodermen," several forms of the madreporic appendages of the different groups of the recent Echinodermata are described. In general they are composed of a soft or moderately hard skin consisting of a minute tissue of calcareous fibres, or of small polygonal plates. The walls are also sometimes minutely poriferous. In all the Holothurians the madreporic organ is a sack attached by one of its ends to the œsophageal canal, the

other extremity hanging freely down into the perivisceral cavity, not connected with the opposite body wall as is the sand canal of the star-fishes. (Op. cit., p. 84.) In its consisting of a convoluted plate the madreporic organ of *Actinocrinus*, therefore, agrees with that of the star-fishes, while in its being only attached at one extremity it resembles that of the Holothurians.

The convoluted plate of the Palæozoic Crinoids and the madreporic sacks and tubes (or sand canals) of the recent Echinoderms, therefore, all agree in the following respects:—

1. They have the same general structure.
2. They are all appendages of the ambulacral system.
3. They are all attached to the same part of the system, that is to say, to the central point from which the canals radiate.

The above seems to me sufficient to make out at least a good *prima facie* case for the position I have assumed. When among the petrified remains of an extinct animal, we find an organ which has the same general form and structure, as has one that occurs in an existing species of the same zoological group, we may, with much probability of being correct in our opinion, conclude that the two are homologous, even although we may not be able positively to see how that of the fossil is connected with any other part. But when, as in this instance, we can actually see that it is an appendage of another organ, or system of organs rather, which is known to be the homologue of the part with which that of the existing species is always correlated, we have evidence of a very high order on which to ground a conclusion. By no other mode of reasoning can we prove that the column of an *Actinocrinus* is the homologue of that of *Pentacrinus caput Medusæ*.

In an important paper entitled "Remarks on the Blastoidea with descriptions of New Species" which Meek and Worthen have kindly sent me, the authors, in their comments upon my views, state that :—

"In regard to the internal convoluted organ seen in so many of the *Actinocrinidæ* belonging to the respiratory instead of the digestive system, we would remark that its large size seems to us a strong objection to such a conclusion. In many instances it so nearly fills the whole internal cavity that there would appear to be entirely inadequate space left for an organ like a digestive sack, outside of it, while the volutions within would preclude the presence of an independent digestive sack there. In addition to this, the entire absence, so far as we can ascertain, of any analogous, internal respiratory organ in the whole range of the recent *Echinodermata*, including the existing Crinoids, would appear to be against the conclusion that this is such, unless we adopt the conclusion of Dujardin and Hupé, that the Palæozic Crinoids had no internal digestive organs, and were nourished by absorption over the whole surface. We should certainly think it far more probable that this spiral organ is the digestive sack, than a part of a respiratory apparatus."

The objection here advanced does not appear to me to be a strong one.

In many of the lower animals the digestive organs are of inconsiderable size in proportion to the whole bulk. In the Brachiopoda, for instance, the spiral ciliated arms fill nearly the whole of the internal cavity, the digestive sack being very small and occupying only a limited space near the hinge. These arms, although not the homologues of the convoluted plates of the Palæozoic Crinoids, have a strong resemblance to them, and are, moreover, at least to some extent, subservient to respiration. They are certainly not digestive sacks. In the recent echinoderms the intestine is usually a slender tube with one or more curves between the mouth and the anus. It fills only a small part of the cavity of the body, the remainder being occupied mostly by the chylaqueous fluid, which is constantly in motion and undergoing æration, through the agency of various organs, such as the respiratory tree and branchial cirrhi of the Holothuridea, the dorsal tubuli of the Asteridæ and the ambulacral systems of canals of the class generally. In no division of the animal kingdom do the respiratory organs occupy a larger proportion of the whole bulk than they do in the Echinodermata. The great size which the convoluted plate attains in some of the Crinoids is, therefore, rather more in favor of its being a respiratory than a digestive organ.

Professor Wyville Thomson says that inside of the cavity of the stomach of the recent Crinoid, *Antedon rosaceus*, there is a spiral series of glandular folds which he supposes to be a rudimentary liver. (Phil. Trans. R. S., 1865, p. 525). It is barely possible that the convoluted plate may represent this organ. At present I think it does not.

I believe that the reason why the convoluted plate attained a greater proportional size in the Palæozoic Crinoids, than do the sand canals of the recent echinoderms, is that the function of the system of canals (of which they are all appendages,) was at first mostly respiratory, whereas in the greater number of the existing groups, it is more or less prehensive or locomotive, or both.

6. *On some points relating to the structure of Pentremites.*

Professor Wyville Thompson has proposed a division of the skeleton of the existing Crinoid, *Antedon rosaceus*, into two systems of plates, which he terms respectively the "*Radial*," and the "*Perisomatic*" systems.* These he considers to be thoroughly distinct from each other in their structure and mode of growth. The radial system consists of the joints of the stem, the centrodorsal plate, the radial plates, the joints of the arms, and also those of the pinnules. In the perisomatic system he includes the

* On the Embryogeny of Antedon rosaceus Linck (*Comatula rosacea* of Lamarck.) By Professor Wyville Thompson, LL.D., &c. Philosophical Transactions of the Royal Society, vol. clv, Part II, p. 540.

Fig. 71.

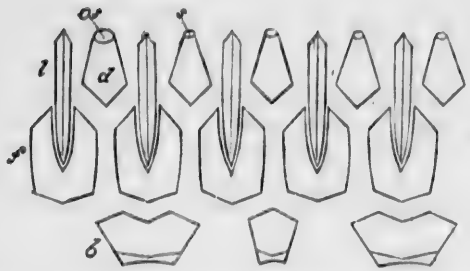


Fig. 72.

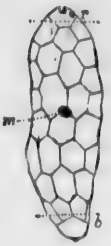


Fig. 71.—Calycine plates of *Pentremites*,—*b*, the basals; *f*, one of the five forked plates; *d*, deltoid plate; *l*, lancet plate; *os*, oral spiracle; *s*, spiracle.
Fig. 72.—*Caryocystites testudinarius*, Hisinger,—*b*, basal plates; *r*, radials; *m*, mouth.

basal and oral plates, the anal plate, the interradial plates, and any other plates or spicula which may be developed in the perisom of the cup or disc. This I think a good arrangement, except in so far as it regards the stem, which appears to me to be, always, an appendage of the perisomatic, rather than of the radial system.

Throughout the whole range of the Crinoidea, the plates of the radial and perisomatic systems, are easily distinguished from each other. In general, the Cystidea have no radial plates in their calyces except, perhaps, in a small area around the ambulacral orifice. This accords well with an important observation of Professor Thomson's on the structure of Antedon, while in the earlier periods of its growth. "The entire body of the Pentacrinoid is," he says, "at first, while yet included within the pseudembryo and during its earliest fixed stage, surrounded and enclosed by plates of the perisomatic system alone, and it is quite conceivable that plates belonging to this system may expand and multiply so as to form a tessellated external skeleton to the mature animal, the radial system being entirely absent, or represented only in the most rudimentary form." (Op. cit., p. 541). Such is the structure of all of the Cystidea. On referring to fig. 72, it will be seen that the whole of the body of *Caryocystites testudinarius*, is covered with polygonal plates, without any trace whatever of a radiated arrangement. The plates are disposed in nine transverse ranges, girding the body like so many rings. This species is, (and so are most of the elongated subcylindrical Cystideans), annulated rather than radiated, so far as regards the external integument. The lower range, below the line, *b*, consists of the basals, whilst the upper, above the line, *r*, may, possibly, be radiated. In all the globular or ovate Cys-

tideans, with numerous plates, such as *Sphæronites*, *Malocystites*, *Comarocystites*, *Amygdalocystites*, and others, the shell is neither annulated nor radiated, but composed of an indefinite number of plates, increasing with the age of the individual, and arranged without any well defined or constant order. It seems clear, therefore, that the test of the Cystidea belongs mostly to the perisomatic system.

In *Pentremites* the three plates which are usually called the basals, consist each of two pieces, one placed above the other, and, in general, closely anchylosed together. The lower pieces have each a re-entering angle, in their upper edges, for the reception of the upper pieces which stand upon them. This structure was first pointed out by Mr. Lyon (Geol. Ky., vol. iii, p. 468), and is not generally admitted, although I believe it certainly does exist. It is said that the lower pieces consist of the upper joint of the column, divided into three by vertical sutures. To me they appear to be calycine plates. It is true that they do not form the bottom of the visceral cavity, but this may be due to the growth inward of the lower edges of those of the upper series. Something like this occurs in *Antedon*, where, at first, the bottom of the cup is formed by the basals, but afterwards principally by the first radials.

The forked plates are usually called "*Radials*" but they certainly do not belong to the radial system. If they did, they would represent the first radials of the Crinoidea, and therefore they should support the bases of the ambulacra. A little consideration will, however, enable any one to perceive that in *Pentremites* the bases of the ambulacra, are situated in the apex of the fossil, and do not come in contact with the forked plates. The apex of *Pentremites* is identical with the actinal centre of Sea-urchins and Star-fishes, in which the mouth is situated. It is here that the ambulacra originate and grow outward by the addition of new plates to their distal extremities. There can be little doubt that such was the mode of growth of the ambulacra of the *Pentremites*. The smaller extremity, therefore, of their ambulacra, which is received into the forked plate, is not the base, but corresponds with the apex of the ambulacrum of a Sea-urchin or of a Star-fish. It also represents the tip of the arm of a Crinoid. If the forked plate is radial, then the arrangement of the ambulacrum must be the same as that which would be exhibited in a Crinoid, with the upper end of the arm downward, and resting on the first radial, whilst the lower end would be upward, the tip being formed of the second radial. From this it follows that the forked plates do not belong to the radial, but to the perisomatic system.

The five deltoid plates alternate with the forked plates, and are also perisomatic.

It is not certain that the lancet plates represent any of those plates which in the Crinoidea are usually called "radials." They are so arranged that if they were loosened from the walls of the cup, and their smaller extremities turned upward, whilst their bases or larger ends retained their position, they would stand in a circle around the apex, as do the arms of an ordinary Crinoid. Their bases would alternate with the apices of the deltoid plates. They would form the outside of the arms, whilst the grooves and pinnulæ would be inside. Each would bear, on its outer or dorsal aspect, two elongated sacks, the two hydrospires that belong to the ambulacrum. I believe that the small groove in the ambulacrum of *Pentremites* was occupied by the ovarian tube only. If this be true, and if, also, the lancet plates represent the radial plates of the arms of the Crinoids, then the arm of *Pentremites* would have the respiratory portion of the ambulacral system on its dorsal, and the ovarian portion on its ventral aspect.

In the true Crinoids, both the respiratory and ovarian tubes are situated in the grooves in the ventral side of the arm.* In the Crinoids the pinnulæ are attached to the radial joints of the arm. In *Pentremites* they are not connected with the lancet plate, but with the pore plates. In *P. pyriformis* they appear to me to stand in sockets excavated in the suture between the pore plates proper, and the supplementary pore plates. Müller compared them to the series of azygos plates, which underlie that portion of the ambulacrum of *Pentacrinus* that runs from the mouth to the base of the arm. These resemble the lancet plates, in their being azygos and not connected with pinnulæ; but then, on the other hand, they differ from them in having, a portion at least, of the respiratory tubes on their ventral aspect. Mr. Rofe says that, "in many species of Pentremites, if not in all, this lancet plate is in reality a compound plate, formed of two contiguous plates, extending from the bottom of the sinus to the top, and, then turning right and left round the summit openings, they pass down the adjoining sinus to form half its lancet-plate, leaving at the apex of the body a pentagonal aperture, supposed to be the mouth. In some

* Thomas Say who was the first to recognize the Blastoidea as a group distinct from the Crinoidea, also supposed the function of the ambulacra to be respiratory. He says, "I think it highly probable that the branchial apparatus communicated with the surrounding fluid through the pores of the ambulacræ, by means of filamentous processes; these may also have performed the office of tentacula, in conveying food to the mouth, which was perhaps, provided with an exsertile proboscis; or may we not rather suppose that the animal fed on the minute beings that abounded in the sea water, and that it obtained them in the manner of the Ascidia, by taking them in with the water. The residuum of digestion appears to have been rejected through the mouth." (Jour. Acad. N. S. Phil. vol. iv, p. 296, 1825).

weathered specimens, the two parts of the lancet plate are separate; and in many they appear to meet only the top and bottom of the cross section, leaving a lozenge-shaped opening between them." (Geol. Mag., vol. ii, p. 249.) In a large specimen of *P. obesus* (Lyon and Cassiday which was given to me by Mr. Lyon, a polished section shows that one of the lancet plates is thus divided, but in general no trace of a suture can be seen in these plates.

There are several points in the structure of the ambulacra of *Pentremites* that are well worthy of the study of those who have plenty of well preserved specimens. Among these, I would direct special attention to the markings in the ambulacrum of *P. pyriformis*. The median groove, which I suppose to have been exclusively occupied by the ovarian tubes, sends off branches, right and left alternately, toward the sides of the ambulacrum. These branches do not run directly to the ambulacrum pores. Each of them terminates at a point between the inner extremities of two of the pores. There is at this point a small pit which appears to be the socket of an appendage quite distinct from the pinnule. The groove does not reach the socket of the pinnule, which is situated further out, between two of the pores. On the other hand a small groove runs from each pore, inward, and terminates at another socket, about half-way between the pore and the main median groove of the ambulacrum. It would thus appear that besides the ordinary pinnules, there were two other rows of appendages on each side of the median groove.

The general conclusions at which I have arrived from the above, are, that all the principal plates that compose the shell of *Pentremites*, belong to the perisomatic system of Professor Wyville Thompson; that it is doubtful whether or not the lancet plates are homologous with the radial plates of the Crinoids; and that the ambulacra are more complicated in their structure than is generally supposed.

7. *On the Structure of the genus Nucleocrinus.*

Fig. 73.

Fig. 74.

Fig. 75.

Fig. 76.

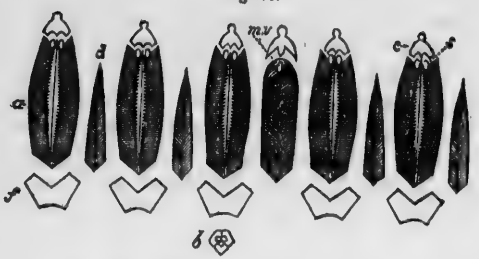


Fig. 73 Apex of *Nucleocrinus Verneuilii* Troost. *g*, ambulacral groove; *p*, pore through which groove enters into the interior; *s*, one of the ten spiracles; *mv*, oro-anal aperture. 74 Anterior side of a specimen; *a*, the anterior interradial. 75 Apex of a specimen which has lost the integument that covered the centre. 76 Diagram of the plates of the test; *a*, ambulacral plates; *b*, the basals; *c*, plates of the apex; *d*, one of the interradials; *f*, forked plate.

The body of this remakable genus is ovate, elliptical or oblong, and inclosed in a shell of strong perisomatic plates, which are, in general, so closely anchyclosed that the sutures between them cannot be distinguished. According to Mr. Lyon, who, through his long continued geological researches, has collected and studied a vast number of specimens, there are three minute, lozenge-shaped, or quadrilateral basal plates, situated at the bottom of the columnar pit, always concealed when the column is present. These are surrounded by three other plates, the six altogether corresponding to the six pieces which constitute the compound basal plates of *Pentremites*. They are represented at fig. *b*, as figured by Mr. Lyon (Geol. Ky., vol. iii, pl. v, fig 1, *b*.)

In the next series there are five plates which are undoubtedly the homologues of the five forked plates of *Pentremites*. They are very short and confined to the base of the body. They form a shallow basin with ten re-entering angles in its margin. Fig. 76 *f*.

Alternating above the forked plates, are five pieces corresponding to the deltoid or interradial plates of *Pentremites*. Some of these are lanceolate in form (fig. 76 *d*), their broader extremities fitting into the angles between the forked plates. They taper to a point upward, and their sides are bevelled so as to pass under the ambulacral plates, to which they are, in general, so closely united, that the line of junction is indicated only by the difference in the markings of the surface. Owing to this structure, these plates have not always been recognized by the authors who have described this genus. They were first pointed out by Mr. Lyon. The fifth deltoid or interradial plate is truncated at its apex for the reception of the

oro-anal orifice (*mv*, figs. 73 76. The sutures on each side of this plate are generally distinctly visible, especially in the upper part of the body.

The ambulacra are narrow—one line wide in a specimen fifteen lines in length, with a fine median groove, about large enough to accommodate a tube of the size of a horse-hair. There are two rows of pores, those on one side of the groove alternating in position with those on the other side. These pores lead into the hydrospires. There appear to be only two rows of ambulacral ossicles. The pores are situated in the sutures between them. On each side of the ambulacrum there is a broad transversely grooved marginal plate. From each pore a small rounded ridge runs across this plate. The grooves between the ridges orginate at the outer extremities of the ambulacral ossicles. In well-preserved specimens the surface of these marginal plates exhibits no other structure than the transverse grooves and ridges; but in one weathered specimen that I have examined they seem to be composed of a number of narrow elongated pieces, arranged transversely, in such a manner that two of them abut against the outer extremity of each of the ambulacral ossicles, and extend outward toward the interradials. This seems to prove that the marginal plates belong to the ambulacra, as pointed out by Mr. Lyon, and not to the interradials, as represented by other authors. Although I have studied a large number of specimens, none of them were sufficiently perfect to enable me to make out the whole structure of this part of the test of *Nucleocrinus*. I have, however, seen enough to convince me that the ambulacra are much more complex than is usually supposed. The lancet plate, if it occur at all in this genus, must be very narrow. The ambulacral groove, as in *Pentremites*, sends off branches, right and left. There is also evidence of the existence of minute marginal plates on each side of the groove.

Fig. 77

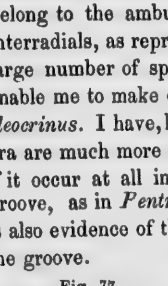


Fig. 77 Traverse section through a specimen which has all the hydrospires preserved. *h*, the two anterior hydrospires; *p*, pore leading into the hydrospire; *g*, one of the grooves.

The hydrospires are ten elongated sacks, each with two deep folds. They are perfectly homologous with those of *Pentremites*, only differing therefrom in not being united in pairs; consequently there are ten spiracles instead of five. The mouth, or oro-anal orifice, is larger in proportion to the size of the body than it is in *Pentremites*. Mr. Meek informs me that the mouth in some of the Blastoidea is protected by a single valve that covered it like the lid of a jug. From the structure of the orifice, I am inclined to think that in *Nucleocrinus* it possessed a similar protection.

In the apex, nearly all the space within the circle of apertures is covered by a thin integument of small plates, fig. 73 When this is not preserved, a large sub-pentagonal aperture is seen, as shown in fig. 75 This aperture occupies the position of the mouth in the existing echinoderms. The integument, as will be shown further on, represents thatwhich covers the mouth of an embryonic Star-fish. Mr. Conrad described this genus in 1842, as having only one aperture in the summit. "This genus differs from PENTREMITES, Say, in having only one perforation at top, which is central." (Jour. Acad. Nat. Sci. Phil., vol. viii, p. 280, pl. xv, fig. 17). His figure represents the fossil with the apex downward. Dr. Ferd. Roemer, showed that, when perfect, there is no central opening, and he made this one of the grounds for separating the genus from *Pentremites*. He described the apex as being provided with six apertures, five of which were divided by a partition within each. These he considered to be the ovarian orifices. The sixth he supposes to be both mouth and vent, which accords with my view. (Mon. der Blastoiden, p. 378). In 1868 I discovered the five small pores at the apical extremities of the ambulacral grooves. In general it is difficult to see these pores, but if a silicified specimen, which has been fossilized in a calcareous matrix, be placed in an acid for two or three minutes, the acid cleans them out and they then become distinctly visible. I believe these to be the pores through which the ovarian tubes passed outward along the grooves to the pinnulæ. There are thus, sixteen apertures in the apex of *Nucleocrinus*,—ten spiracles, five ovarian orifices, and one oro-anal aperture. There are no true radial plates. The whole of the test with the exception, perhaps, of the ambulacra belongs to the perisomatic system.

8. *On the occurrence of Embryonic forms among the Palæozoic Echinoderms.*

No proposition in Natural History has been more clearly demonstrated than this:—That, in general, the paleozoic animals resemble, both in external form and internal structure the embryonic stages of those of the same class at present existing. Prof. Agassiz has long taught in his lectures and various publications, that this is especially observable in the Echinodermata. Judging from the figures and descriptions of Muller, Agassiz, Thomson, Carpenter and others, I should say, that in this class, the most striking resemblance is that which occurs between the adult stages of the Cystidea, Blastoidea, and Crinoidea, on the one hand, and the embryonic Star-fishes on the other. The structural character that has the most important bearing on the subjects discussed in these notes, is, that in all four of these groups, the

mouth is situated in one of the interradial areas,— not in the ambulacral centre, as it is in the adult forms of the existing Echinodermata.

Fig. 78,

Fig. 79,

Fig. 80,

Fig. 81.

Fig. 78 *Bipinnaria asterigera* Sars, (copied from Müller), *a*, the stomach; *b*, part of the body of the larva; *c*, ambulacral centre, position of the permament mouth, in this stage not open; *d*, one of the five ambulacral canals; *e*, sand canal, *f*, madreporic plate; *m*, entrance into the stomach; *o*, œsophagus; *p*, larval mouth or pseudostome; *r*, œsophageal ring; *v*, vent 79 Ideal figure described below. 80 *Codonites stelliformis*, oblique view to show both body and summit. 81 Summit of fig. 80.

In *Bipinnaria asterigera* Sars, according to Müller, the digestive cavity is a sub-globular sack without any extension sinto the rays, as there are in the adult Star-fishes. The œsophagus, fig. 78, *o*, is a fleshy, consisted tube with a large mouth or pseudostome, *p*. It passes through the wall of the stomach by an opening somewhat smaller than the mouth, and situated in one of the interradial spaces at *m*. The madreporic plate, *f*, and sand canal, *e*, the latter holding the convoluted plate (when it occurs), are situated above the orifice, *m*, and between it and the ambulacral centre, *c*. The circular space at *c*, is undoubtedly the homologue of the central space in the apex of *Nucleocrinus*, figs. 73 and 75, and of *Codonites*, figs. 80 and 81. It is also the position of the mouth in the adult Star-fish; but in the larval stage it is completely closed by the soft external skin and sarcode of the body. In the fossils it is also closed, but by an integument of thin calcareous plates. The *Bipinnaria* is nourished by minute particles of matter diffused through the water, and drawn into the digestive sack through the mouth and œsophagus by the action of internal cilia. I believe that all the fossil Crinoidea, Blastoidea and Cystidea, ingested their food in this way, and without any aid whatever from the arms or pinnulæ.

Perhaps there is no embryologist who will not admit, that it is possible for an animal like *Bipinnaria* to develop organs of reproduction and

propagate its species, none of its other parts making any farther advance. Such an animal, with some slight modifications, would not be very widely different from a palæozoic Crinoid. If the sarcodic body wall were to be consolidated into a thin calcareous integument, with the mouth even with the surface, the swimming appendages aborted, and the vent closed up, it would resemble the cup of an *Actinocrinus*, fig. 79 *a*. The lateral orifice would then be both mouth and vent, as it is, at first (according to Prof. A. Agassiz Seaside Studies, p. 125), in the embryo of *Asteracanthion Brylinus*. The ambulacral canals of *Bipinnaria* are the homologues, in a general way, of those which are found beneath the vault of *Actinocrinus*, and extend out into the grooves of the arms. If the ventral perisome of the Crinoid were to be removed (the internal organs remaining undisturbed) the arrangement disclosed would be that represented in fig. 79 a convoluted plate in the centre with the canals radiating from it. The most striking difference is the absence of the œsophageal ring. According to the organization of *Actinocrinus* there could be no œsophagus at that point, and consequently there is no ring. The convoluted plate represents the madreporic apparatus. The sucking feet of the Star-fish, most probably, represent the respiratory tentacles that border the grooves of the Crinoids, but modified into prehensile and locomotive organs. *Bipinnaria* and *Actinocrinus* agree in having the mouth in one of the interradial areas, and in the absence of an orifice through the perisome at the ambulacral centre. These two characters are embryonic and transitory in the Star-fish, but they were permanent in most palæozoic Crinoids.

In *Codonites stelliformis* (*Pentremites stelliformis* Owen and Shumard), figs. 80, 81 the ambulacral centre *c*, is completely closed. Five minute grooves radiate out to the extremities of the five angles of the disc. These grooves are identical with those of *Pentremites* and *Nucleocrinus* and were occupied by the ovarian tubes. The ambulacral canals of the true Crinoids and of the Star-fishes are represented in a rudimentary condition, in the species, by the hydrospires which open out to the surface through the ten fissure-like spiracles, *s*. The oro-anal orifice is interradial. *C. stelliformis* in external form, the interradial position of the mouth, and the closed ambulacral centre, resembles *Bipinnaria* and *Actinocrinus*, but differs importantly in having its respiratory organs arranged in ten separate tracts, all totally disconnected from each other. It is a lower form than *Actinocrinus*, which in its turn is lower than *Bipinnaria*, and yet all three are constructed on the same general plan.

C. stelliformis, although much resembling a *Pentremite*, is a true Cystidean. Its affinity to *Codaster* was first pointed out by Dr. C. A. White, who also suggested that it should be assigned to a distinct group. (Bost.

Jour. N. H., vol. vii, pp. 486, 487). The main difference between the Cystidea and the Blastoidea is, that in the former the hydrospires do not communicate with the pinnulæ, whilst in the latter the cavities of the pinnulæ and hydrospires are directly connected by the ambulacral pores.

The development of the recent Crinoid *Antedon rosaceus*, as described by Prof. Wyville Thomson (Phil. Trans., 1866), persues a course that could not possibly result in the production of such an animal as *Actinocrinus*. The pseudembryo, as it is called by Prof. Thomson, is a small ovate organism, with four transverse ciliated bands, a large key-hole-shaped mouth (pseudostome), and a small circular vent (pseudoproct). These orifices are connected by a rudimetary intestine (pseudocele). In this stage there is no trace of radiation, and the mouth, therefore, cannot be said to be interradial in its position.

The nascent Crinoid orginates within the pseudembryo, but developes a mouth, vent and stomach, of its own, all quite distinct from those of its nurse. This new, or permanent mouth, is for a short time both oral and anal in its function, but although in this respect it resembles that of *Actinocrinus*, its position in the centre of the ambulacral system shows it to represent the mouth of the adult Star-fish, while that of *Actinocrinus* rather homologates with the oral orifice of the *Bipinnaria*. At no time during its development does the ventral perisome exhibit the structure of that of the palœocrinoids, i. e., no orifice in the ambulacral centre, and at the same time one in an interradial space. In the central position of its mouth, and in the possession of an œsophageal ring, *Antedon* stands above *Actinocrinus* in rank, and between it and the adult Star-fish. In none of its stages does it resemble a *Bipinnaria* either in form or in structure.

9. *On some of the objections that have been advanced against the views advocated in the preceding notes.*

In all the known species of the existing Echinodermata, the mouth is situated in the centre of the ambulacral system, and it is contended that this fact proves that such must have been its position also in the palæozoic forms.

This reasoming is not strictly logical. It is true that in the known existing species, the mouth is in the centre, but it does not certainly follow that it is so in all the Echinodermata, living and extinct. Whether it be so or not in any particular fossil species whose structure may be under investigation, *is a question of fact which can only be positively determined by direct observation of specimens.* On appealing to these we find that, in a large proportion of the fossil forms, there is no aper-

ture in the perisome at the ambulacral centre. It also becomes evident by the comparison that in general, the palæozoic species resemble the embryonic stages of some of the recent Echinoderms, and that in these, (*Bipinnaria* for instance), the mouth is interradial. Rules such as are relied on in this case, afford a certain amount of presumptive evidence, which, however, cannot prevail against material and visible facts. When we can see clearly that there is no aperture in that point, in the vault of a Crinoid, beneath which we know the ambulacral centre is situated, it is perfectly useless to supply one by theory.*

The second objection is, that many of the fossils have a *Platyceras* attached to them, in such a position as to cover the aperture which I call the mouth, and under such circumstances as to induce the belief that it lived parasitically on the Crinoid. The only answer I can make to this is that, admitting the facts, we must suppose that space was left for a stream of water to pass under the edge of the shell, into the mouth of the Crinoid. In general, where one animal lives parasitically upon another, it does not destroy its host. Some of the gasteropods of the Devonian and Carboniferous ages were carnivorous, as is proved by the bored shells and Crinoids that are occasionally found. I have seen a number of such specimens, and several years ago I read apaper on the subject (which was never published) before the Natural History Society of Montreal. There were several good Conchologists present, and the specimens exhibited were compared with bored shells of existing species. All pronounced the style of workmanship to be precisely the same. I have the proboscis of an *Actinocrinus* that is bored near the base, and among the fossils lent me by Mr. Wachsmuth, is a *Codonites stelliformis*, that is bored through one of the ambulacra. The view I took of the subject in my paper, was that the gasteropod ascended the stalk of the Crinoid and thrust its proboscis into the mouth of the latter. The Crinoid then slowly drew its arms together, and held the shell fast until both died.

Fig. 82 *Streptorhynchus Pandora*. A specimen bored at *o* by a carnivorous gasteropod. From the Corniferous Limestone, Devonian, Canada.

* The position of the ambulacral centre may thus be found. When the mouth is eccentric, the ambulacral tubes usually converge to the centre of the vault. But when the mouth is central, we first find the azygos interradius, in general easily recognized by its possessing a greater number of plates than do any one of the other four interradii. On the opposite side of the fossil is the azygos arm. The ambulacral centre is always situated between this arm and the mouth, never on the side of the mouth toward the azygos interradius.

A third objection is the small size of the aperture in some of the species. In general, where there is no proboscis, the orifice is from one-twentieth to one-tenth of an inch in diameter, quite sufficient for an animal that subsists on microscopic organisms. It is stated by Meek and Worthen that where there is a proboscis, the aperture is sometimes scarcely "more than *one-hundredth* of an inch in diameter." I believe that in many such instances the tube filled up by calcareous deposits on its inside, and that when entirely obstructed, either a new aperture opened out in the side of the proboscis, or that the animal died. In Mr. Wachsmuth's collection, I saw a specimen with a second aperture in process of formation. A ticket was attached to it by him, giving this explanation. I am also informed that in some of the existing species of *Antedon* "the mouth is an exceedingly minute aperture."

A fourth objection is that the aperture is so situated that the arms could not have conveyed food to it. It is, however, proved by Dr. W. B. Carpenter, that in the recent Crinoids the arms are not prehensile organs. The animal while feeding remains motionless, attached by its dorsal cirrhi to a stone, shell, or other object on the bottom. Its arms are either stretched out to their full length, or more or less coiled up, but quite immovable. As Dr. Carpenter's remarks have a very important bearing upon the subject, I shall take the liberty of quoting the following:—

"Whatever may be the purpose of the habitual expansion of the arms, I feel quite justified that it is *not* (as stated by several authors whom I have cited in my historical summary) the prehension of food. I have continually watched the results of the contact of small animals (as Annelids, or Entomostracans and other small Crustaceans with the arms, and have never yet seen the smallest attempt on the part of the animal to seize them as prey. Moreover, the tubular tentacula with which the arms are so abundantly furnished, have not in the slightest degree that adhesive power which is possessed by the "feet" of the ECHINIDEA and ASTERIADA; so that they are quite incapable of assisting in the act of prehension, which must be accomplished, if at all, either by the coiling-up of a single arm, or by the folding-together of all the arms. Now I have never seen such coiling-up of an arm as could bring an object that might be included in it into the near neighborhood of the mouth; nor have I seen the contact of small animals with a single arm produce any movement of other arms towards the spot, such as takes place in the prehensile apparatus of other animals. Moreover, any object that could be grasped either by the coiling of one arm, or by the consentaneous closure of all the arms together upon it must be far too large to be

received into the mouth, which is of small size and not distensible like that of the ASTEROIDA."*

Farther on Dr. Carpenter says:

"It was affirmed by M. Dujardin (l'Institut, No. 119, p. 268) that the arms are used for the acquisition of food in a manner altogether dissimilar to ordinary prehension; for recognizing the fact that the alimentary particles must be of small size, he supposed that any such, falling on the ambulacral (?) furrows of the arms or pinnæ, are transmitted downwards along those furrows to the mouth wherein they all terminate, by the mechanical action of the digitate papillæ which fringe their borders. This doctrine he appears to have abandoned; since in his last account of this type (Hist. Nat. des Echinoderms, p. 194) he affirms that the transmission of alimentary particles along the ambulacral (?) furrows is the result of the action of cilia with which their surface is clotted. Although I have not myself succeeded in distinguishing cilia on the surface which forms the floor of these furrows, yet I have distinctly seen such a rapid passage of minute particles along their groove as I could not account for in any other mode, and am therefore disposed to believe in their existence. *Such a powerful indraught, moreover, must be produced about the region of the mouth, by the action of the large cilia which (as I shall hereafter describe) fringe various parts of the internal wall of the alimentary canal, as would materially aid in the transmission of minute particles along those portions of the ambulacral (?) furrows which immediately lead toward it;* and it is, I feel satisfied, by the conjoint agency of these two moving powers that the alimentation of Antedon is ordinarily effected. In the very numerous specimens from Arran the contents of whose digestive cavity I have examined, I have never found any other than microscopic organisms; and the abundance of the horny rays *Peridiinum tripos* (Ehr.) has made it evident that in this locality that Infusorium was one of the principal articles of its food. But in Antedons from other localities, I have found a more miscellaneous assemblage of alimentary particles; the most common recognizable forms being the horny casings of ENTOMOSTRACA or of the larvæ of higher CRUSTACEA." (Op. cit., p. 700

The existence of large cilia within the intestinal canal, capable of producing a powerful indraught of [illegible]ter, renders any movement or concurrent action of the arms quite unnecessary in the ingestion of food. It does not matter, therefore, in what part of the body the mouth of a Crinoid may be situated, or how remote from the reach of the arms.

* Researches on the Structure, Physiology, and Development of *Antedon* (*Comatula* Lamk.) *rosaceus*.—Part I. By W. B. Carpenter, M.D., F.R.S. Philosophical Transactions of the Royal Society, vol. clvi, Part II., 1866.

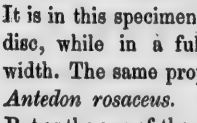
Attached permanently to the bottom of the sea by their columns, the palæozoic Crinoidea, Cystidea and Blastoidea remained, while feeding, most probably motionless, drawing in streams of water through their mouths by the action of their intestinal cilia. The long tubular proboscis, with which many of the species are provided, would be, thus, analogous in function to the siphon of the acephalous mollusca. The indigestible particles would be, from time to time, thrown out through the mouth, just as a Star-fish or a Zoophyte frees itself of the refuse portions of its food, by casting it out of the same aperture through which it entered.

10. *On the Theory that the ambulacral and ovarian orifices are the oral apertures.*

Assuming that the four objections above noticed are sufficient to prove that the aperture which I call the mouth is not that organ, it is contended that the Cystidea, Blastoidea and Palæocrinoidea ingested their food through their ambulacral and ovarian orifices. This appears to me in the highest degree improbable. In the recent Crinoids the grooves of the arms are occupied by four sets of tubes, which Dr. Carpenter calls the cœliac, the sub-tentacular, the ovarian and the tentacular canals. None of them communicate with the stomach. It is impossible that the most minute particle of food could gain access into the interior of the animal through any of them. The structure of the arms of the palæozoic Crinoids is such, that we must presume that their grooves were occupied by similar tubes, which passed through the ambulacral orifices into the perivisceral space. In the Cystidea and Blastoidea the respiratory organs were not situated in the grooves of the arms, and the ambulacral orifices were therefore only ovarian in their function. The improbability of their being also oral apertures is best shown by an illustration.

In fig. 84, is represented (natural size) the apertures of the smallest specimen of *Caryocrinus ornatus*, in our collection selected for the present purpose because in the young of this species, the valvular orifice is larger in proportion to the size of the disc, than it is in the adult. It is in this specimen, about one-third of the whole width of the apical disc, while in a full grown *Caryocrinus* it is only one-ninth of the width. The same proportional size of the mouth according to age, occurs in *Antedon rosaceus*. The valvular mouth at first is as wide as the disc. But as the age of the animal increases the disc grows wider, but the mouth does not. The ovarian pores in *Caryocrinus* are, however, as large in the small ones (once they make their appearance) as they are in full grown.

Fig. 83 Fig. 84.



For recognizing these as ovarian pores we have the following reasons 1. They are situated at the bases of the arms where the ovarian tubes must pass from the grooves into the perivisceral cavity. 2. When compared with the ovarian pores of a Sea-urchin they have the same size, form and aspect. Fig. 84, represents the ovarian pores of the Sea-urchin *Toxopneustes Drobachiensis* Ag. natural size and arrangement. It may not appear at first view that this latter comparison has any probative effect. But it has, in this way. If these apertures in *Caryocrinus* were large openings a like wide, as are some of the ambulacral orifices of the Crinoids, I would say that they were unlike true ovarian apertures.

According to the new theory, this Echinoderm *Caryocrinus ornatus* was a polystome animal, and drew in its food through its six ovarian apertures, the large valvular orifice being the anus. To me this appears to be utterly incredible.

In fig. 83 I have represented the mouth of *Leskia mirabilis* Gray. Both Dr. I. E. Gray and Prof. Lovén have pronounced this aperture to have the structure of the valvular orifice of the Cystidea. I have not the slightest doubt whatever but that the mouth of the Cystideans foreshadows that of the Sea-urchins. There is nothing whatever in its structure to show that it is not the mouth, but on the contrary.

The new theory is not founded upon any peculiarities in the structure of the ambulacral orifices, which would show that they are oral apertures, but only upon the four objections above noticed. The first of these is not logical, while at the same time it is purely theoretical, and avails nothing against material and visible facts. The fourth is completely disposed of by Dr. Carpenter's observations, which prove that in the Crinoidea the arms have no share whatever in the ingestion of food. The second and third objections are the same in substance, i. e., according to the second the supply of water to the mouth is diminished by the occurrence of a *Platyceras* over it, while, according to the third, the same effect is produced by the small size of the aperture itself in some instances. It does not require much consideration to convince one, that if these two objections are fatal to my views, they are equally so to the opposite theory. In *C. stelliformis* for instance, the pores through which we must suppose the ovarian tubes issued from the interior are only large enough to admit of the passage of a fine hair. They are scarcely visible to the naked eye. The tube, under any circumstances, must have filled them almost entirely. If any space at all were left for the passage of a stream of water through the pore by the side of the tube it must have been exceedingly minute.

When weighed as above, therefore, the evidence gives the following results:— The first and fourth objections avail nothing. The second and

third militate against both theories. But when we take into account that in no instance, in the existing Echinodermata, where ovarian pores occur, are they at the same time oral orifices, the balance seems to be in favor of my view. This is all I desire to say upon the subject at present. Although I now firmly believe that the valvular orifice in the Cystidea, the larger lateral aperture of the Blastoidea, and the so-called proboscis of the palæozoic Crinoids are all oro-anal in function, yet I shall not maintain that view obstinately against good reason shown to the contrary.

Corrections and additions.

According to Prof. J. Müller's observations, it appears that in the existing Crinoid, *Antedon Europæus*, there is no annular canal around the mouth. In the interior of the body there is a soft spongy substance, which is full of small cavities that connect with each other through numerous slender canals. This substance forms a pillar, the base of which rests upon the bottom of the internal cavity of the cup, whilst the summit touches the inner surface of the ventral integument, on one side of the mouth. Müller says it forms a sort of a spindle, around which the intestine is wound. The ambulacral canals all terminate in this spongy spindle.* The upper part of the spindle, therefore, towards which all the canals converge, and in which they all terminate, must be regarded as the centre of the ambulacral canal system. If I have understood him rightly, the canals radiate, not from the mouth, but from the spindle. The mouth is situated not in the spindle but on one side of it, and it cannot, therefore, be the centre of the ambulacral canal system. He makes no mention whatever of a circular canal around the mouth. The structure would be similar to that shown in fig. 50, ante p. 92, where the shaded central space C, from which the canals radiate, may represent the upper end of the spindle of *A. Europæus* and *mv* the mouth.

It may be that I have not interpreted Müller's description correctly, or that he may have been mistaken. If it be as I understand it, then the oft cited rule, that the mouth is the ambulacral centre in "*all*" of the existing Echinodermata, must undergo an important alteration. The word "*all*" must be struck out. Before such a change, however, can be made, we must have the details of the structure and con-

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* Ueber den Bau des *Pentacrinus caput Medusæ*, p. 58. He says.—"Wo die Tentakelrinne vom Arm. auf die Scheibe übergeht bleibt der Canal unter der Tentakelrinne und gelangt mit diesen zum Mund, in dem er weiter wird und zwischen Perisom und Bauchholenhaut verlauft. Am Munde senkt er sich in eine den Hohlen ein, welche zahlreich die spongiose mittlere Masse den Scheibe durchziehen, Alle 5 Canale munden in diese ein"

sections of the spongy axis of *Antedon* worked out with certainty. Although Müller's figure 9, pl. 5, represents the œsophagus (Speiserohre) as situated entirely on one side of the upper end of the spindle, yet it may be, that a portion of the spongy mass, forms a ring around it. In that case it might represent the circular canal of the other echinoderms.

It is said that the orifice, in the Cystidea and fossil Crinoids, which I believed to have been both oral and anal in function, is anatomically, identical with the anus of the existing Crinoids. If this be true, and if my theory is correct, it must follow that the Cystidea took in their food through the anus. The same phenomenon has been observed in an immature star fish. In the earlier stages of the growth of *Asteracanthion berylinus* (Agassiz) a common star fish in the Atlantic. Prof. A. Agassiz finds that there is, at first, only a single opening to the digestive sack. This opening is both mouth and anus. Afterwards a second opening is formed which is the permanent mouth. "The other opening, which was the first to be developed, thus becomes the anus."* This star-fish, therefore, in its embryonic stages takes in its nourishment through the anus. In this respect it is a Cystidean. I am informed that the same arrangement occurs also in the *Ophiurians* and *Echini*. Granting, therefore, that the valvular orifice of the Cystidea is the anatomical homologue of the anal tube of a *Pentacrinus*, it does not follow that it was exclusively anal in its function. I, however, do not admit it to be the homologue of the anus of *Pentacrinus*. I believe it to be the mouth.

I have stated (ante p. 91) that :—"In this class (the Echinodermata) the position of the various organs, in relation to each other, and also to the general mass of the body, is subject to very great fluctuations." In addition to the few examples of such variations there given, the following may be cited :—

1.—The aperture which, in an embryonic Echinoderm is both mouth and anus, may, in the mature stage, become the anus only, a new mouth being formed in another part of the body.

2.—It may become the permanent mouth, and a separate anus be formed in another part.

3.—The mouth may be, at first, situated out of the centre of the ambulacral canal system, and afterwards removed to it.

I believe, that this latter process took place, in the development of the orders Cystidea and Crinoidea. In the first formed or palæozoic species the mouth was not central, but has become so in the existing types.

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* On the Embryology of *Asteracanthion berylinus*, &c., by A. Agassiz. Proc. Am. Acad. Vol. VI., p. 108.

In the foregoing pages the ambulacral apertures of the Cystidea and Blastoidea are treated of, as having been entirely reproductive in their function. This view, however, can only be correct, in so far as regards those genera that have calycine pores or hydrospires. There are some that have no poriferous structures in the test or body-wall, and to such the rule does not apply. For example :—in fig. 85 the two apertures of the Cystidean *Malocystites Murchisoni* are given, natural size, drawn from a specimen in which they are very perfectly preserved. I believe that the larger of these two openings is the mouth and anus combined. The smaller is the ambulacral aperture. The body-wall is totally non-poriferous, and, consequently, it could not have been respiratory. If this species possessed any external respiratory organs at all (such as those that are situated in the grooves of the arms and pinnules of the existing Crinoids) they must have communicated with the interior, through this smaller aperture. Whatever, therefore, may have been its other functions it must have been, at least in part, a respiratory orifice. There are two grooves issuing from it. Each of these divides into four or five branches, which radiate over the surface of the test, and extend down the sides, in some specimens, nearly to the base. If the ovaries were situated in the pinnules, and if there were any connection between them and the interior, that connection must have been made by the agency of one or more organs passing through this same smaller orifice. Assuming this to be true, then this opening was both respiratory and reproductive. It should not therefore be called the "ovarian" but the "ambulacral aperture" as it was originally designated in my decade No. 3.

Fig. 85.

The above relates, only to those Cystideans which have not pores or hydrospires in the test or body-wall. With regard to those that have pores, such as the *Sphæronites*, or those that have hydrospires (*Glyptocystites, &c.*) there may have been two kinds of respiratory organs.

1. The pores or hydrospires.
2. The ambulacral canals, in the grooves of the arms.

Granting that this was the case, then these latter could only communicate with the interior through the smaller apical aperture (Fig. 85.) This orifice would, therefore, be both respiratory and reproductive, as it probably was in *Malocystites*. It should be called, simply, the "ambulacral aperture."

5. *On some of the Fossils of the Arisaig series of rocks.* Upper Silurian, Nova Scotia.

Lamellibranchiata.

The genera *Orthonota* (Conrad) 1841, *Sanguinolites* (McCoy) 1844, and *Goniophora* (Phillips) 1848, seem to be all closely related to each other. The following references to these genera are, therefore, to be regarded as merely provisional.

Orthonota venusta. (N. sp.)

Plate 8, fig. 1.

Description.—Shell transversely elongate; length about four times the height; dorsal and ventral margins nearly parallel, slightly diverging posteriorly; beaks situated at about the anterior fourth of the length. Behind the umbones the hinge-line is straight, and extends nearly the whole length of the shell. In front of the umbones it is also straight, but at a somewhat lower level than behind. The anterior extremity is nearly vertically truncated for a short distance below the hinge-line, then rounded into the ventral margin; the latter appears to be slightly convex. The posterior extremity is not well preserved in any of the specimens examined, but appears to be nearly vertically truncated in the upper two-thirds, and rounded below. The valves are moderately convex; an obscure rounded angulation extends from the umbones backwards and downwards to the lower posterior angle. Above this the shell is compressed, or even gently concave. A similar rounded angulation runs from the umbones to the lower anterior angle.

The surface, at the anterior extremity, exhibits usually eight or nine narrow but strongly elevated ridges. Before the beaks these descend, nearly vertically from the hinge-line, to the anterior umbonial slope, over which they bend with a narrowly rounded curve, and then slope backwards and downwards in straight parallel lines towards the ventral margin. Three or four of the most anterior ridges seem to die out on reaching the margin. The others become parallel to the margin for a short distance, and then turn upwards to the dorsal margin. Above the posterior umbonial ridge, there are three or four shallow grooves, which originate in a point near the umbones, and gradually radiate backwards to the upper half of the posterior extremity. The concentric ridges are more acute and strongly elevated on the anterior than they are on the posterior part of the shell.

Length of the best specimen collected, twenty-three lines. Height at the umbones, five and a-half lines.

None of our specimens are perfect, and all have the outlines more or less concealed in the stone. The posterior extremity seems to be narrowly rounded in the lower third, nearly straight or slightly curved in the upper two-thirds. It seems also to be somewhat broader than the anterior. The surface characters of the posterior two-thirds of the shell, are less distinct than they are in the anterior third.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.

Collector.—T. C. Weston.

ORTHONOTA INCERTA. (N. sp.)

Plate 8, fig. 4.

Description.—Shell transversely elongate, length about three times the height, beaks between one-fourth and one-fifth the whole length, from the anterior extremity. Dorsal margin behind the umbones straight. Ventral margin slightly concave for about two-thirds the length, rounding upwards at each end. The anterior extremity is short, rounded about two-thirds the whole height of the shell. The posterior extremity appears to be obliquely truncated in the upper half, rounded in the lower. The valves are moderately convex. From the umbones, a rounded angulation extends to the lower posterior angle. Above this the surface has an abrupt slope upwards, becoming somewhat concave on approaching the dorsal margin. A shallow concavity extends from the umbones to the ventral margin.

Surface with concentric wrinkles, four or five in the width of two lines on the anterior half, becoming smaller backwards; above the oblique angulation somewhat smooth. From the umbones, backwards and downwards to the ventral margin, there are from four to six rather sharp radiating, elevated lines, with concave grooves between them.

Length of the largest specimen examined, twenty-one lines; height at the umbones, seven lines; depth of both valves about five lines.

The specimens are not sufficiently well preserved to exhibit all that is required to determine the genus. It looks like a slender elongated *Goniophora.*

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.

Collector.—T. C. Weston.

ORTHONOTA ? SPECIOSA: (N. sp.

Plate 8, fig. 3.

Description.—Transversely elongate, ovate; length about three times

the height; beaks at about one-sixth the length from the anterior extremity. Dorsal and ventral margins sub-parallel, slightly converging posteriorly. Anterior extremity short, the margin broadly rounded up to the hinge-line with which it appears to form a right angle. Outline of the posterior extremity unknown, but apparently rounded. Ventral margin gently convex. Both valves are moderately convex. A narrow groove runs from the umbo backwards to the ventral margin, which it reaches a little behind the mid-length.

Surface on the anterior extremity with four or five strong concentric ridges. These remain single to a point nearly beneath the beak when their number is doubled by the intercalation of new ones, and apparently by the fission of one or two of the old. Proceeding backwards the surface markings become more and more obscure. The umbones are covered with neatly rounded concentric ridges, about five in one line on approaching the beaks, but becoming coarser, receding therefrom, down the sides. A set of fine rounded striæ radiate from the beak over the umbones, but disappear at about half the height of the shell. On the umbones there are five or six of those striæ in the width of one line.

The oblique sulcus running from the umbones to the ventral margin is a character that would seem to ally this species to the genus *Grammysia*. In *Orthonota undulata*, (Conrad.) there is, however, a similar sulcus in precisely the same position.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Orthonota Simulans. (N. sp.)

Plate 8, fig. 2.

Description.—Transversely elongate, length about thrice the height, slightly convex; dorsal and ventral margins parallel; anterior extremity short, the most projecting point at about half the height, thence broadly rounded downwards and backwards to the ventral margin; beaks at about one fifth the whole length of the shell behind the anterior extremity; dorsal margin straight from the beaks backwards for about three fifths the whole length; posterior margin in the upper half, sloping at an angle of about 130° with the dorsal; lower half narrowly rounded. On the umbones a flattening of the surface commences, which, gradually widening and becoming slightly concave, extends to the ventral margin. Just behind this, a moderately strong, broadly rounded angulation extends from the umbones backwards and downwards, to the lower posterior angle. The dorsal margin is somewhat strongly compressed.

Surface with obscure concentric striæ, from four to six in the width of two lines, on the anterior half of the shell. In passing backwards, they curve over the oblique carination, and then run with a slope forward, to the straight portion of the hinge line. From the beaks six or eight fine thread-like radiating striæ run backwards and downward. They are parallel to and just in front of the carina.

Length of the specimen described about twenty six lines; height at the umbones eight and a half lines; depth of the left valve about three lines.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Orthonota angulifera? (McCoy.)

Sanguinolites angulifera, (McCoy.) Pal. Foss. p. 276, pl. 1 k, figs. 19, 20.

Plate 8, fig. 13

Description.—Of this species there is only the impression of the anterior half of the right valve in the collection. The anterior extremity projects, a little more than one-half the height of the shell, beyond the beaks. Its surface is marked by six sharply elevated ridges, which, commencing on the hinge line descend obliquely downwards and backwards to the ventral margin. The sixth ridge, from the end, does not quite reach the margin, but turns upwards at an angle of about 80° and ascends the side of the shell, sloping a little forwards, for about two-thirds the height. Within the angular space, inclosed by the two parts of this ridge, there are two others, shorter but similarly angulated ridges. From the umbones three obscure concave folds slope backwards, as in *O venusta*. These are crossed by obscure nearly vertical grooves, from the hinge-line downwards, about six of these in two lines.

This shell seems to be proportionally wider behind than those figured by McCoy, but to differ from them in no other material respect.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Modiolopsis exilis. (N. sp.)

Plate 8, fig. 5, 5 a.

Description.—Shell transverse, sub-ovate; slightly arcuate; length a little more than twice the height; hinge-line nearly straight, slightly convex, extending backwards to about the posterior third of the length of the shell; ventral margin in some specimens gently concave, in others in the anterior half and slightly convex behind; curved upwards at each

extremity. Beaks situated at about the anterior fourth, closely incurved. Anterior extremity about half the height of the shell, uniformly rounded below, apparently narrowly rounded or sub-angular above. Posterior margin obliquely sloping, from the end of the hinge line downwards to about the mid-height of the shell, below this sub-truncate or broadly rounded. From the umbones, an obtusely rounded angulation extends to the lower posterior angle; above this the shell has a flat, gently convex or gently concave slope to the hinge-line and posterior margin. Below and in front of the angulation the sides of the shell are gently convex, or partly concave and partly convex.

Surface with strong concentric ridges, four to six in two lines, at the anterior end. On the sides and at the posterior extremity the ridges are finer but accompanied by more or less strongly impressed concentric grooves or interruptions of growth.

Length of a large specimen, twenty-eight lines height of the same at the umbones, twelve lines.

This specimen is closely allied to *M. Platyphylla* (Salter), and should, perhaps, be regarded as merely a geographical variety thereof. According to the figures in the (Mem. Geol. Surv. G. B. vol. 2, pl. 20) the lower posterior angle of the English fossil is more pointed and the ventral margin more widely sinuated. The anterior extremity is corrugated as in our species, but the sides and posterior extremity are smoother. McCoy says: "Surface nearly smooth, with numerous small concentric wrinkles of growth towards the margin." Pal. Foss. p. 268 *M. complanata* (Sowerby,) is another allied form, and occurs in the same geological horizon. It seems to be more prominently arched on the dorsal line; the anterior extremity is larger and the surface smoother.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.

Modiolopsis ruda. (N. sp.)

Plate 8, fig. 6.

Description.—Shell transverse, length about twice the height; beaks nearly terminal; dorsal margin straight, and gradually elevated from the beaks backwards to a point a little behind the mid-length; posterior margin obliquely truncated, gently convex, nearly straight, forming with the dorsal margin an obtuse angle of about 135°; the lower ventral angle narrowly rounded; ventral margin nearly straight, sometimes gently concave for about one half the length in the middle, curving upwards at each end. The anterior extremity is small, half the height of the shell, projecting

only about one-tenth the whole length of the shell, beyond the beaks. From the beaks a moderate angulation extends obliquely backwards and downwards, to the posterior ventral angle. Above this the slope to the dorsal and posterior margins is flat or obliquely concave.

Surface, at the anterior extremity, with strong rounded concentric ridges, four to six in the width of two lines, their number increasing on the sides of the shell, both by sub-division and intercalation, while they become flatter and broader. On crossing the carina, the striæ form a narrowly rounded curve, and turn upwards to the hinge-line, running parallel to the obliquely truncated posterior margin. Where the surface is perfect, a set of very fine striæ may be seen on and between the principal ridges. On one of the specimens there is an obscure elevated line running from the umbones downwards to the ventral margin, which it reaches a little behind the mid-length.

Length of an averaged sized specimen, sixteen lines; height of the same at the umbones, about seven lines; height at the posterior extremity of the hinge-line, about eight lines.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Goniophora transiens. (N. sp.)

Plate 8, fig. 7.

Description.—Shell transverse, sub-rhomboidal, moderately and irregularly convex, with an acute, gently sigmoid angulation, extending from the beaks backwards to the lower posterior extremity; beaks situated at about the anterior third of the length, closely incurved; ventral margin gently convex, slightly sinuated in the middle; dorsal margin somewhat straight, anterior extremity uniformly rounded, occupying somewhat over two-thirds the whole height; posterior margin obliquely truncated, slightly convex, forming with the dorsal margin an angle of about 135°; the lower posterior angle is acute, nearly on a line with the ventral margin.

Behind the carina, the surface descends with a flat or gently concave slope, to the posterior and dorsal margins. At the beak, a flattening of the surface (or a slight concavity) commences, and, gradually widening, extends to the ventral margin, occupying rather more than the middle third of the side of the shell. The concavity occurs a little in front of the mid-length. The flattening extends backwards to the carina. The anterior third is moderately convex.

Surface in the anterior third with rather strong, rounded, concentric

ridges, from two to four in the width of two lines. These are rounded on the upper part, but become more acute towards the margin. On the sides of the shell backwards to the carina, the surface is smoother, but still the ridges are obscurely indicated. There is also a set of very fine striæ on and between the ridges. The posterior portion of the shell behind the carina is marked chiefly by the fine striæ. There are also obscure indications of a few radiating striæ, extending from the beaks towards the ventral margin, obliquely backwards.

Of this species, only two specimens are in our collection. The right valve of one of these is two inches in length and nine lines in height, (allowing for a small portion concealed in the matrix.) Depth of both valves about seven lines. The other specimen (pl. 8, fig. 7) two and a half inches in length; height eleven lines; depth about three lines.

This latter differs from the first, in having the space behind the carina gently convex. It may be a distinct but closely allied species. More specimens would be required to decide this question.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.

Collector.—T. C. Weston.

Goniophora consimilis. (N. sp.)

Plate 8, Fig. 8.

Description.—Semi-ovate; length a little more than twice the height; greatest height at about one-third the length from the anterior extremity; beaks nearly terminal, closely incurved, situated at about half the height of the shell. On a side view, (placing that portion of the shell, which lies below the umbonial ridge, vertically) the outline of the anterior, dorsal and posterior margins together, constitute an almost continuous semi-ovate curve, most obtuse and uniformly rounded in the anterior half and descending with a gently convex or nearly straight slope from about the mid-length to the lower posterior angle. With the plane of the entire margin of the shell vertical, a small portion of the hinge line is seen above the ridge, extending back about two-thirds the length; thence the posterior margin descends with a gently convex slope to the lower angle. The umbonial ridge is very prominent; its edge not acute but truncated to the width of half a line or a little more; in one specimen it seems to have groove running along its whole length. The anterior extremity projects about two lines beyond the beaks. The ventral margin is nearly straight or gently concave, the anterior fifth curving upwards and a small portion at the posterior extremity curving downwards.

Surface (of the specimen figured) with very fine transverse striæ six to

eight in one line, as seen on the anterior extremity. These are separated at intervals of from half to one line, by obscure grooves. At the carina the striæ are coarser, three or four in one line. There are no radiating striæ.

Length of largest specimen collected about two inches. Height of the side below the umbonial ridge, eleven lines. The height of the shell, when placed in the usual position, would be somewhat less than eleven lines.

This may be the species cited as *G. cymbæformis* (Sow.) in the Rev. D. Honeyman's paper "On the Geology of Arisaig, Nova Scotia, (Jour. Geo. Soc., vol. 20, p. 344.) It is certainly closely related thereto but still appears to be distinct. The figure in the "Silurian system," plate 5, fig. 6, shows the beaks extending beyond the anterior extremity. Again, Prof. McCoy (Pal. Foss, p. 275) says, "anterior side very small, scarcely extending as far as the beak." In one species the anterior extremity extends a little beyond the beak. It has also the edge of the carina obtuse and even slightly grooved.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Goniophora bellula. (N. sp.)

Plate 8, fig. 9.

Description.—Shell trapezoidal, moderately convex; length not quite twice the height; dorsal and ventral margins sub-parallel; anterior end projecting a little beyond the beaks; posterior extremity abruptly truncated, nearly straight, gently convex, forming an angle of about 90° with the ventral margin; curving forwards, upwards and joining the line at an angle of about 110°. Ventral margin nearly straight, all except the anterior fifth which is curved upwards. The beaks seem to be at about two-thirds the height of the shell, and a little behind the most projecting anterior point. The angulation is moderately developed, rounded when a little worn, when perfect with a sharp elevated rib-like edge.

The sides of the shell below the carina flattened or gently concave, from near the front backwards; from the beaks downwards moderately convex. Above the carina, with a flat or gently concave slope.

Surface with five or six transverse striæ, in a width of two lines. These are crossed in the middle two-thirds by more distinct radiating striæ, six to eight in two lines. A small portion of the anterior extremity with only. the transverse lines. Above the carina the striæ are finer, the surface when not magnified appearing nearly smooth.

Length of the specimen figured fourteen lines; height at the umbones eight lines.

The specimen figured has the anterior margin concealed in the matrix. There are three other specimens, slightly more elongated, and with the sides more concave below the carina; more convex above.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Goniphora mediocris.

Plate 9, fig. 1.

Description.—Shell transversely elongate; length thrice the height. Ventral margin with the posterior third gently curved upwards; a portion consisting of a little more than the middle-third nearly straight or slightly concave; the anterior fourth rounded upwards. The dorsal margin appears to be nearly straight or gently convex and sub-parallel with the ventral margin for about half the length behind the umbones, and then sloping downwards to the posterior angle. Beaks nearly terminal.

The valves are strongly carinated; the dorsal portion slightly concave between the carina and the hinge-line, becoming somewhat convex on approaching the posterior extremity. Below the carina the sides descend with a convex slope, a very obscure concavity about the middle third. None of the specimens have the anterior extremity perfect, but it seems to project slightly beyond the beaks. The carina, as seen in casts of the anterior, has the edge narrowly rounded or sub-acute; it is most probably acute where the shell is preserved. Surface with three or four striæ in the width of one line, below the carina; with finer striæ above

Length of the specimen figured twenty-four lines; height at the umbones eight lines; depth, at about the mid-length, six lines.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Cytherodon? placidus. (N. sp.)

Plate 8, fig 10.

Description.—Cast of the interior of the right valve, oblong or broadly sub-ovate; length one-fifth greater than the height at the umbones; depressed convex; beaks a little behind the anterior third; anterior extremity broadly rounded; ventral margin gently convex in the middle three-fourths, broadly rounded up to the anterior extremity, more abruptly curved up to the posterior margin; dorsal margin occupying

about the middle half of the whole length of the shell; parallel to the ventral margin nearly straight or slightly convex. The lower half of the posterior margin is gently convex; the upper half straighter and sloping to the posterior end of the hinge line.

From the beak a nearly straight fold runs down to the basal margin, which it reaches at a point between the posterior fifth and sixth. Another similar fold runs to the posterior margin a little above the mid-height. Behind each of these folds the surface is slightly depressed, making two step-like descents backwards.

The dorsal margin, above the last fold, is compressed, slightly concave. Just below the hinge line there is a row of, apparently twelve to fifteen impressions of small teeth, which slope upwards and slightly backwards. No teeth can be seen in front of the beaks. Surface of the cast, with impressions of fine concentric striæ, apparently six or seven in two lines.

Length sixteen lines, height at the umbones ten lines.

Variety.

Plate 8, fig. 11.

The above description is founded on the specimen represented by fig. 10. But there are several others, which differ from that in having the posterior extremity obliquely sloping from the end of the hinge-line downwards (Fig. 11.) The beaks also vary in position from about the anterior third to near the mid-length. At present, I shall retain them as a variety.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Cytherodon? socialis. (N. sp.)

Plate 8, fig. 12.

Description. Transversely elongate ovate; length nearly thrice the height; moderately convex; beaks between the anterior fifth and fourth; anterior extremity rounded, from three-fourths to seven-eighths the whole height; ventral margin gently convex; hinge-line straight, a little more than half the length between the beaks and the posterior end. A shallow groove runs from the beaks backwards and downwards, to the lower posterior angle. The surface, as seen in the casts of the interior, is slightly depressed above the groove. A second depression occupies a small space below the hinge-line, and somewhat resembles a long lunette. The posterior extremity is either doubly truncated or irregularly rounded.

Surface with fine rounded striæ four or five in one line and also with obscure concentric wrinkles, not always seen on the casts.

Length of large specimens about two inches; height eight or nine lines. Individuals of all sizes from nine lines in length upwards occur.

The position of the beaks varies, from one-fifth to three-eighths the length from the anterior extremity. The posterior part of the shell is often more narrowed and pointed, from the beaks backwards, than it is in the specimen figured; sometimes more obtuse and uniformly rounded.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Grammysia remota, (N. sp.)

Plate 9, fig. 2.

Description.—Sub-ovate or sub-triangular, the height nearly equal to the length; beaks a little in front of the mid-length. The whole of the margin of the lower half of the shell is broadly rounded, or depressed semicircular. The anterior extremity is most prominent at about the mid-height; above which point, it is gently convex, or nearly straight in outline, and sloping towards the beaks; below the mid-height it gradually curves into the ventral margin. The hinge line and dorsal margin slope downwards nearly to the mid-height of the shell, nearly straight or slightly concave. A lunette extends from between the beaks about two-thirds the length of the dorsal margin.

Surface with rather strong concentric wrinkles from half to one line wide, covered with very fine concentric striæ.

Length of the only specimen collected, twenty-six lines; height from the ventral margin to the beaks, twenty-two lines; depth of both valves, nine lines.

The specimen is somewhat distorted and compressed laterally. When perfect the depth of both valves was probably twelve lines.

From the beak of the right valve, a shallow groove extends, almost vertically to the lower third.

Grammysia rustica (N. sp.)

Plate 9, fig. 3.

Description.—Shell transversely elongate-ovate; length nearly twice the height; anterior extremity the largest; beaks at about the anterior third of the length; ventral margin moderately and uniformly convex; dorsal margin nearly straight; sloping downwards from the umbones.

Anterior extremity most projecting, at about half the height of the shell; the outline descending with a broad curve to the ventral margin; apparently a little concave at the upper three-fourths of the height just below the beaks. Posterior extremity about two-thirds the height of the shell, rounded or slightly angular at mid-height.

The valves are moderately and somewhat uniformly convex, most tumid a little above the mid-height and in the anterior two-thirds of the length. From the umbones a narrow groove descends to about the middle of the ventral margin.

Surface of the anterior extremity with obscure rounded concentric ridges, nearly two lines wide, narrower in the upper half and on the umbones. On the sides and posterior half, in one specimen, a set of fine striæ four or five in one line are visible.

The two specimens collected have the hinge line buried in the matrix, and it cannot therefore, be determined, whether they possess the lunette characteristic of the genus or not.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Grammysia Acadica. (N. sp.)

Plate 9, fig. 4, 4*a*.

Description.—Shell oblong or obliquely ovate, strongly convex; beaks anterior; dorsal and ventral margins sub-parallel, the dorsal often elevated posteriorly. Anterior end often nearly vertically sub-truncate, (as in fig. 4 *a*.), sometimes more or less obliquely sloping backwards from the beaks, and downwards to the ventral margin. The latter is generally moderately convex, sometimes straightish in the middle, or with a slight concavity in the anterior half. The most projecting point of the posterior extremity is about the mid-height of the shell, where it is usually rounded or obscurely angular; above the middle, with a nearly straight, or gently curved slope, forwards and upwards to the posterior end of the hinge line; below, rounded to the ventral margin. The hinge-line is straight or slightly concave, and extends backwards to a point varying in position, between the mid-length and the posterior fourth, usually about half-way between the two. The beaks are closely incurved, almost if not quite in contact with each other. There is a small anterior lunette, often almost obsolete; a large one behind the beaks extends nearly the whole length of the hinge-line.

The lateral groove commences at the beaks, and runs backwards and downwards, to the lower half of the margin of the posterior extremity.

It is often very obscurely marked. The position of the point where it reaches the margin, is sometimes situated near the mid-height of the posterior end of the shell, but is usually lower down; often higher up in one valve than in the other.

The surface is covered with concentric ridges from half a line to two lines wide. There are, also, very fine striæ, four or five in one line, on and between the larger.

Length of a large specimen twenty-seven lines; height at the umbones fourteen lines, depth of the two valves in connection fourteen lines.

This is, probably, the species that has been referred to *G. cingulata*, from which it differs in having the groove terminating near or on the lower half of the posterior extremity, instead of in the middle of the ventral margin.

In many of the specimens, the anterior margin slopes obliquely backwards and downwards, so that, when the fossil is placed upright resting on the middle of the ventral margin, the beaks constitute the most projecting point of the anterior end. The hinge-line is also often so much elevated that its posterior extremity is near the mid-length of the shell, and forms there a prominent, obtuse angle. The form is then more or less rhomboid-ovate instead of oblong-ovate. In front of the groove an obscure concave depression, in the side of the shell, commences and gradually widening extends to the base. This is always present, but is often barely perceptible.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Genus Pteronitella. (N. Gen.)

Among the fossils collected at Arisaig, there are many casts of the interior of several species congeneric with *Avicula retroflexa* (Hisinger.) These show that, in front of the beaks, there are several small, anterior cardinal teeth, and that close beneath the hinge-line there are several more or less elongated posterior teeth. This arrangement is quite different from that of both *Avicula* and *Pterinea*, to which these shells are usually referred. There is a strong anterior muscular impression, and the whole structure of the hinge resembles closely that of *Cyrtodonta*.

Prof. McCoy has noticed these teeth in his description of *P. retroflexa* (Pall. Foss., p. 262), but did not seem to think their structure of generic importance. I propose to separate *P. retroflexa* and others of similar structure, from *Pterinea*, and to place them in a new genus:—*Pteronitella*.

Pteronitella venusta. (N. sp.)

Plate 9, figs. 5, 5*a*.

Description.—Hinge line straight, extending a short distance in front of the beak, and, behind the umbones, backwards to about the posterior extremity of the body of the shell. Anterior extremity, in the upper fourth part of the height, forming a small triangular projection in front of the beaks; the lower three-fourths sloping downwards and gradually curving backwards, into the ventral margin. The latter is uniformly rounded, the greatest depth being about the mid-length or a little behind. The most projecting point of the posterior extremity of the body of the shell is a little below the mid-height. Below this point the outline curves downwards and forwards, passing gradually into the ventral margin. Above the same point there is a curve, at first forwards, and then backwards, to the posterior extremity of the hinge line, the sinus thus formed being at about three-fourths the height of the shell.

The right valve is nearly flat; the left is moderately and obliquely convex from the umbones to the lower half of the posterior extremity. The posterior wing is either flat, gently concave, or very slightly convex. The anterior wing is flat for a small space at its extremity; behind this, slightly convex, and then with an obscure depression running from the beak, downwards and sloping slightly backwards, for one-half the height of the shell or a little more. The beak of the right valve is situated at about the anterior fifth.

The best preserved impression of the hinge-line shows four anterior teeth. The first of these slopes downwards and forwards; the other three downwards and backwards. There appears to be two lateral teeth in the right valve and one in the left. They are about one-fourth the length of the shell, and situated in the middle part, close to the hinge-line.

Surface concentrically striated. On the anterior wing the striæ are lamellose, and closely crowded together. On the body of the shell (of the large specimen figures, fig. 5.) the striæ are for the greater part fine, simple, sharply elevated ridges, about one line distant from each other, and with nearly flat spaces between. The surface of the smaller specimens is more closely striated. On the posterior half of the shell, the striæ, above the mid-height, curve forwards, and then backwards and upwards to the hinge-line, thus forming a rounded sinus with the convexity towards the umbones.

Length of the largest specimen collected, thirty-two lines, on the hinge line. Height, at a little behind the middle, sixteen lines. Length

of a smaller specimen, twenty-five lines; height near the middle, thirteen lines.

In *P. retroflexa* (Hisinger) the hinge-line is considerably longer than the body of the shell, while the anterior wing is not acutely pointed, as in this species, but truncated at nearly a right angle.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Pteronitella oblonga. (N. sp.)

Plate 9, fig. 7.

Description.—Transversely oblong; length, a little less than twice the height. Dorsal margin straight, equal to the greatest length of the shell. Ventral margin, in the middle two-thirds, gently convex or nearly straight, sub-parallel with the dorsal margin, curved upwards at both extremities. Anterior extremity rounded in the lower third; in the upper two-thirds nearly straight or gently convex, forming with the hinge-line an angle of 85° or 90°. The beaks are situated at about the anterior fifth. The most projecting point of the posterior extremity is a little below the mid-height; above this the margin is slightly sinuated, and reaches the hinge-line at an acute angle of about 75°.

The left valve is moderately and broadly convex, most tumid in the anterior half, somewhat flattened in the upper part of the posterior portion.

Surface with fine concentric striæ, five or six in two lines, some of them more strongly elevated than the others. On one specimen very fine obscure radiating striæ are seen, eight to ten in two lines. When partially exfoliated the surface has a smoothish aspect. There are two or three lateral teeth, which occupy the middle third of the length, close below the hinge-line. Several small anterior teeth.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.

Pteronitella curta. (N. sp.)

Plate 9, fig. 6.

Description.—Length on the hinge-line from one-eighth to one-sixth greater than the height. Dorsal margin straight, equal to the greatest length or a little more. Beaks about the anterior fourth. Anterior margin descending nearly vertically from the hinge-line, nearly straight or

slightly concave in the upper third; very gently convex in the middle and broadly below into the ventral margin. The latter is gently and uniformly convex in the middle, and broadly rounded upwards at each end. The posterior extremity is nearly at a right angle to the hinge-line in the upper half, straight or slightly concave. In the lower half it is obtusely rounded into the ventral margin. In one specimen, the lower half projects two or three lines further back than the end of the hinge-line.

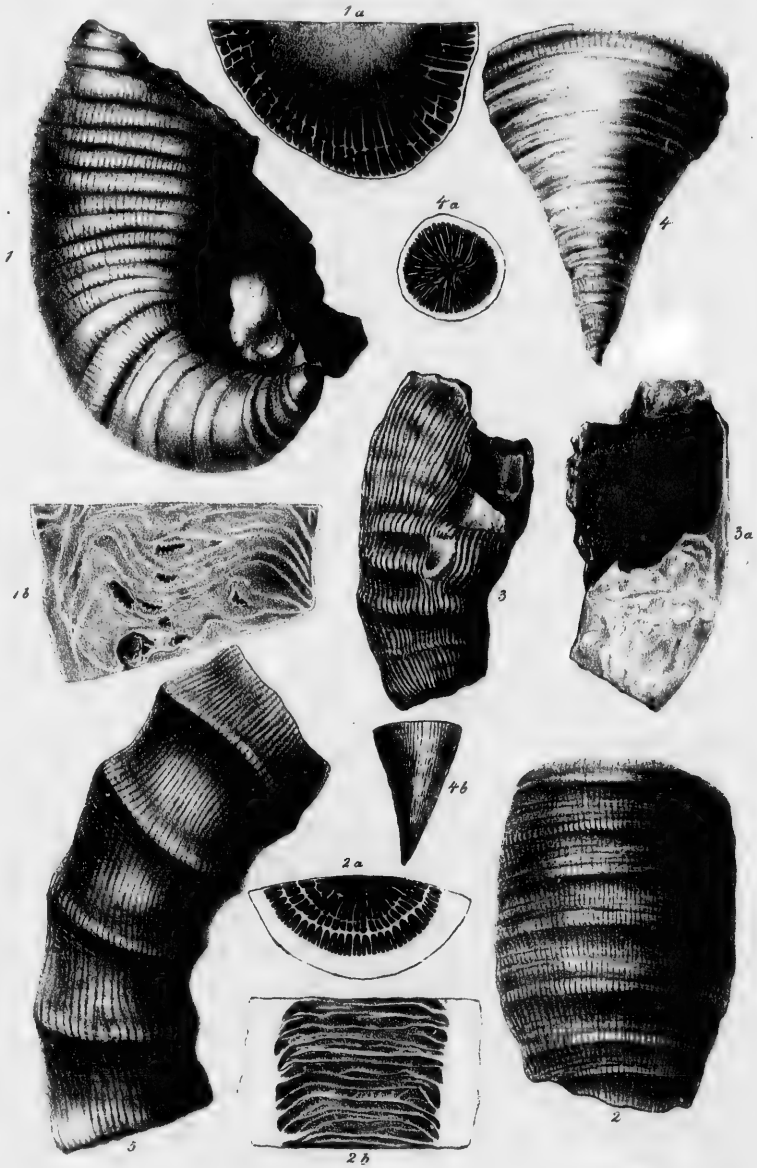
The right valve is moderately convex, depressed, concave, flat, or very slightly concave, below the posterior half of the hinge.

One specimen shows the impressions of three lateral teeth close beneath the hinge in the middle third. Another exhibits four small anterior teeth.

Surface concentrically striated, four or five in two lines, closer and sub-lamellose on the small anterior wing.

Length of an average specimen, twenty-one lines; height, eighteen.

Locality and Formation.—Arisaig, Nova Scotia. Upper Silurian.
Collector.—T. C. Weston.



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Roberts & Co imprt

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t C? impt

PLATE I.

ZAPHRENTIS INCONDITA (page 7).

Figure 1. Base of a specimen.
" 1*a*. Half of a transverse section.
" 1*b*. Longitudinal section, showing the undulated diaphragms.

ZAPHRENTIS RUGATULA (page 8).

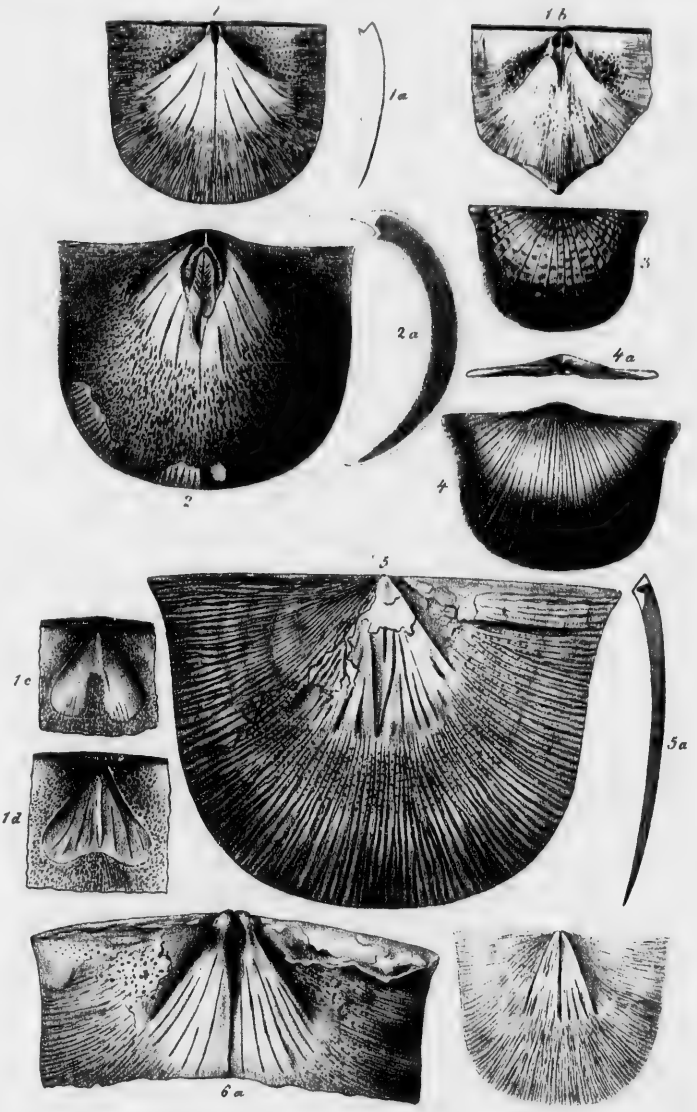
Figure 3. Upper part, including cup.
" 3*a*. Longitudinal section, showing the depth of the cup.

ZAPHRENTIS CORTICATA (page 9).

Figure 4. A specimen, perfect to the base.
" 4*a*. Transverse section of the same.
" 4*b*. Base of a specimen.
" 2.
" 2*a*. } Supposed to be of this species.
" 2*b*.

ZAPHRENTIS CINGULOSA (page 10).

Figure 5. The only specimen collected.



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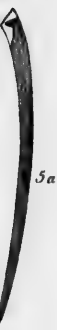


PLATE II.

STROPHOMENA BLAINVILLEI (page 28).

Figure 1. A cast of the inner surface of the ventral valve.
" 1*a*. Longitudinal section, through the beak.
" 1*b*. A cast of the interior of part of a dorsal valve.
" 1*c*. 1*d*. Muscular impressions of S. PERPLANA from the Pal. N. Y., Vol. 4.

STROPHOMENA MAGNIVENTRA (page 22)

Figure 2. Inner surface of ventral valve.
" 2*a*. Longitudinal section.

STROPHOMENA VARISTRIATA (page 26).

Figure Ventral valve.

STROPHOMENA INEQUIRADIATA (page 24).

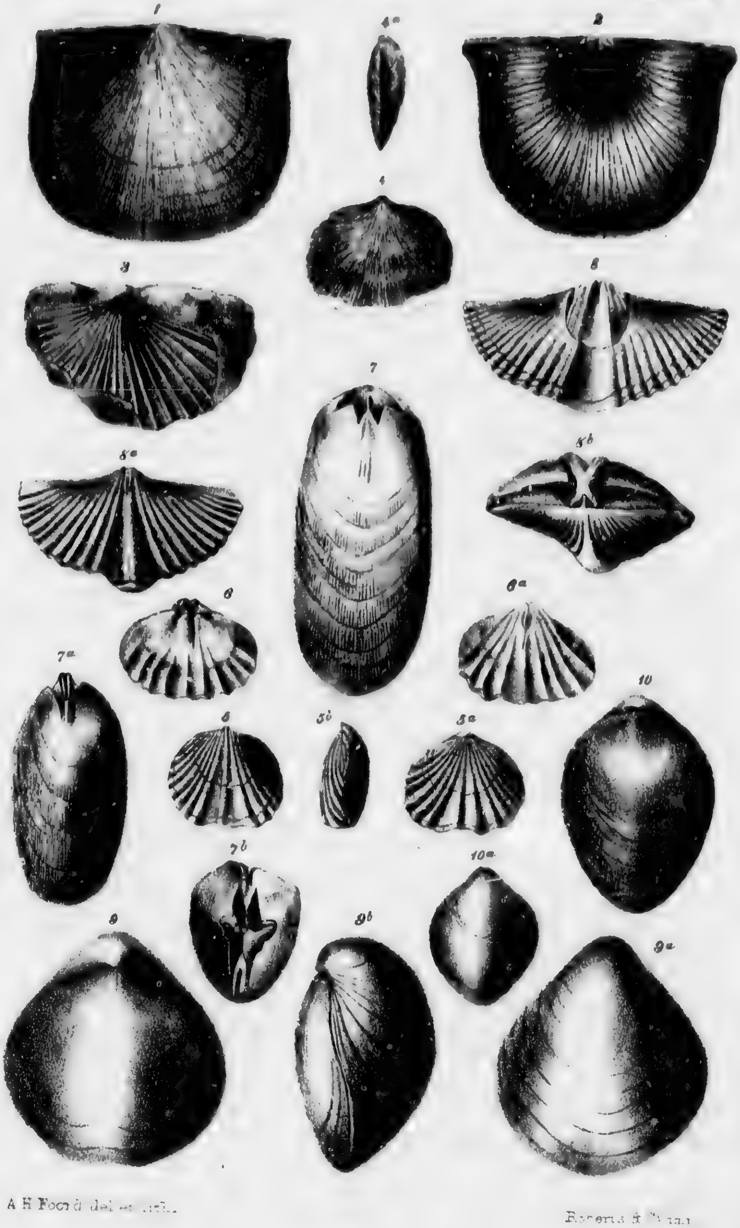
Figure 4. Ventral valve.
" 4*a*. Area of ventral valve.

STROPHOMENA IRENE (page 27).

Figure 5. Ventral valve.
" 5*a*. Longitudinal section.

STROPHOMENA TULLIA (page 29).

Figure 6. Cast of inner surface of ventral valve.
" 6*a*. Cast of inner surface of part of a large ventral valve.



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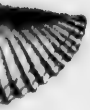

PLATE III.

Figure 1. Ventral valve of S. BLAINVILLEI page 28.
" 2. Dorsal view of STROPHOMENA PUNCTULIFERA, page 30.
" 3. ORTHIS AURELIA, part of ventral valve (page 34).
" 4. ORTHIS LUCIA, ventral valve (page 35).
" 4*a*. " " side view.

LEPTOCOELIA FLABELLITES (page 42).

Figure 5. Ventral valve.
" 5*a*. Dorsal valve.
" 5*b*. Side view.
" 6. Cast of interior of dorsal valve.
" 6*a*. Cast of interior of ventral valve.

RENSSELAERIA OVOIDES (page 41).

Figure 7. Cast of interior of dorsal valve.
" 7*a*. " " " ventral valve
" 7*b*. " " " rostral extremity.
" 10 & 10*a*. Supposed to be a variety of *R ovoides*.

SPIRIFERA GASPENSIS (page 44).

Figure 8. Cast of interior of ventral valve.
" 8*a*. " " " dorsal valve.
" 8*b*. " " " hinge line, &c.

ATHYRIS.

Figure 9. Dorsal view, 9*a*, ventral, 9*b*, side. This is supposed to be A. ARCUATA.—MERISTA ARCUATA, Pal. N. Y., vol. 3.

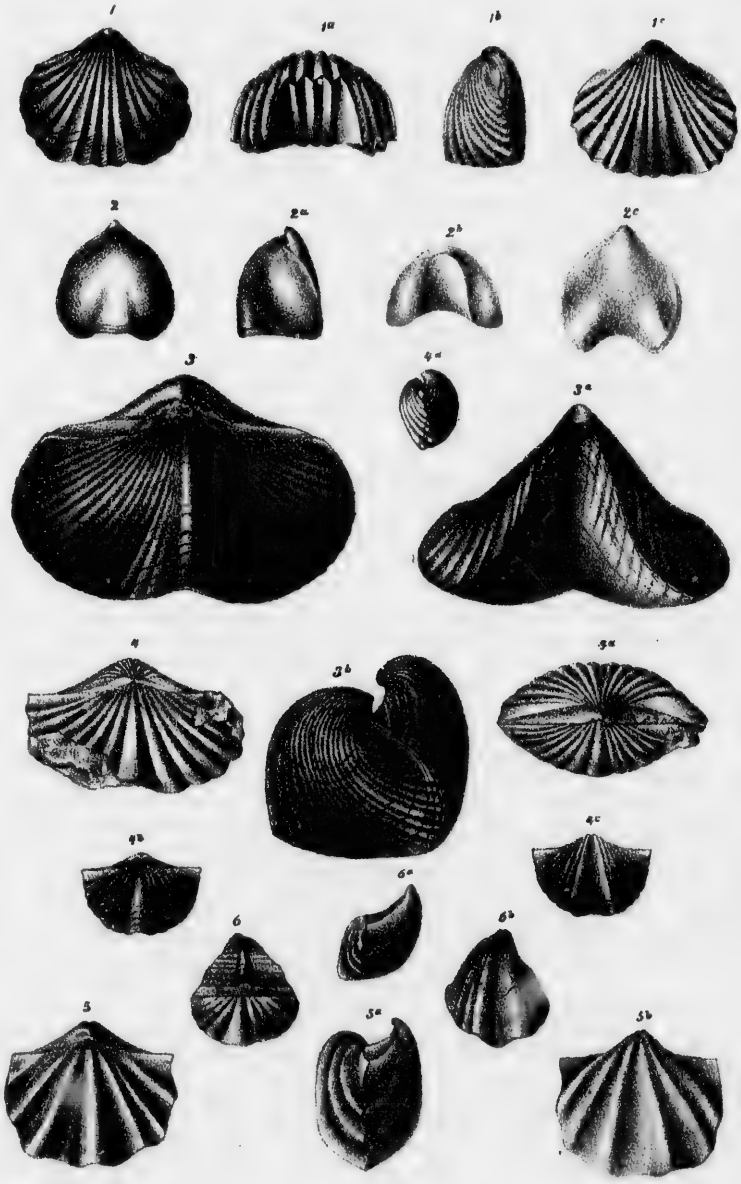

Figure 1
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Figure 2
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Figure 3
" 3a
" 3b

Figure 4.
" 4a
" 4b
" 4c

Figure 5.
" 5a
" 5b

Figure 6.
" 6a
" 6b.

PLATE IIIa.

RHYNCHONELLA DRYOPE (page 37).

Figure 1. Dorsal view.
" 1*a*. Front "
" 1*b*. Side "
" 1*c*. Ventral "

EATONIA PECULIARIS (page 40).

Figure 2. Dorsal view.
" 2*a*. Side "
" 2*b*. Front "
" 2*c*. Ventral "

SPIRIFERA SUPERBA (page 45).

Figure 3. Dorsal view.
" 3*a*. Front "
" 3*b*. Side "

SPIRIFERA CYCLOPTERA (page 48).

Figure 4. Dorsal view of an imperfect specimen.
" 4*a*. Hinge view of the same.
" 4*b*. Dorsal view of a smaller specimen.
" 4*c*. Ventral view of the same.

SPIRIFERA RARICOSTA (page 47).

Figure 5. Dorsal view.
" 5*a*. Side "
" 5*b*. Ventral "

CYRTINA AFFINIS (page 49).

Figure 6. Dorsal view.
" 6*a*. Side "
" 6*b*. Ventral "


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2a
3a
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PLATE IV.

PTERINEA TEXTILIS ?

Figure 1. Supposed to be AVICULA TEXTILIS, Hall; Pal. N. Y., vol. 3.

MYTILARCA CANADENSIS (page 52).

Figure 2. Left side of a cast.
" 2*a*. Anterior side of the same.

GRAMMYSIA CANADENSIS (page 51).

Figure 3. Left valve.

MODIOMORPHA INORNATA (page 52).

Figure 4. Right valve.

SANGUINOLITES TETHYS (page 50).

Figure 5 Right side of a cast.
" 5*a* Hinge view of the same

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PLATE V.

LITHODOMUS CANADENSIS (page 54).

Figure 1. Right valve.

PLATYOSTOMA AFFINIS (page 60).

Figure 2. A cast of the interior.

PLEUROTOMARIA DELIA (page 61).

Figure 3. A cast of the interior.

PLEUROTOMARIA LYDIA (page 62).

Figure 4. Left side of a cast.
" 4*a*. View of the spire.

PLEUROTOMARIA VOLTUMNA (page 61)

Figure 5. Posterior side of a cast.
" 5*a*. View of the spire.

MURCHISONIA HEBE (page 57).

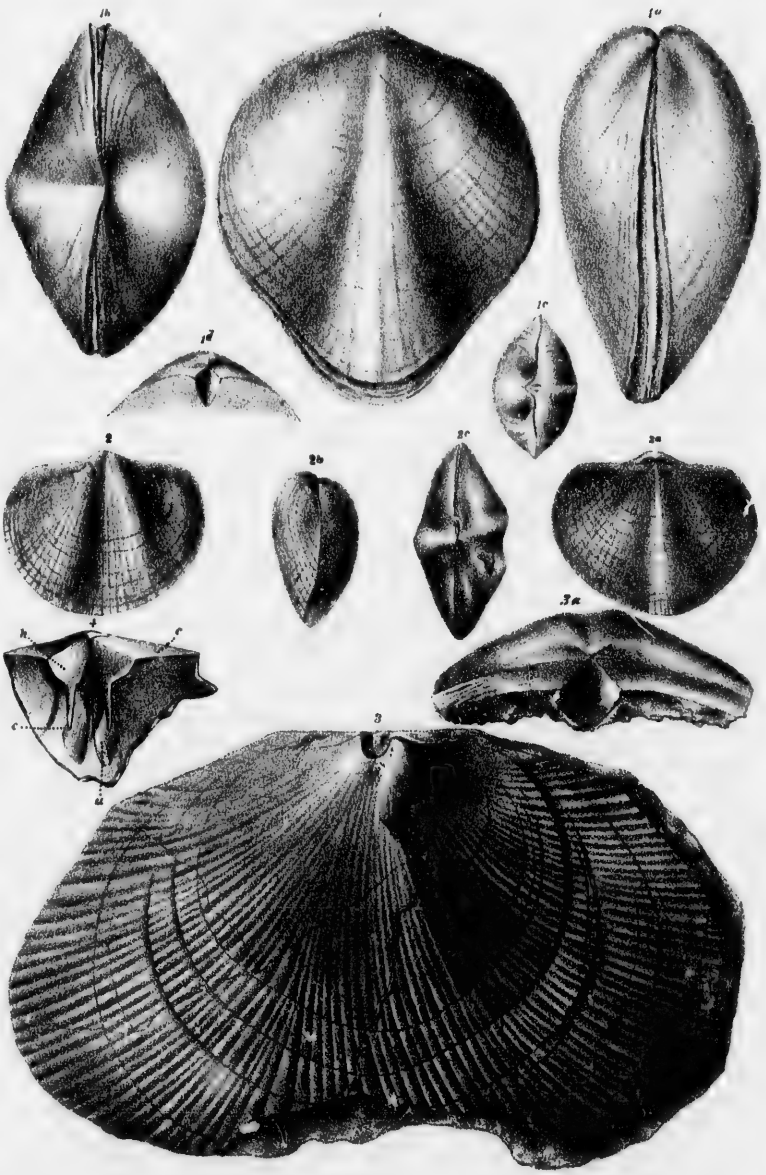
Figure 6. Cast of the interior.

MURCHISONIA EGREGIA (page 58).

Figure 7. Cast of the interior.

BELLEROPHON PLE[illegible] (page 62).

Figure 8. Dorsal view.
" 8*a*. Side.
" 8*b*. Front.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3
3a
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c
a

PLATE VI.

STRICKLANDINIA DAVIDSONII (page 86).

Figure 1. Dorsal view.
" 1*a*. Side.
" 1*b*. Hinge.
" 1*c*. Hinge view of a smaller specimen with the beaks ground off. It shows a section of the triangular chamber in the ventral valve.
" 1*d*. A fragment showing the chamber.

STRICKLANDINIA BREVIS (page 84).

Figure 2. Ventral valve.
" 2*a*. Dorsal valve.
" 2*b*. Side.
" 2*c*. Hinge.

STRICKLANDINIA CANADENSIS (page 81).

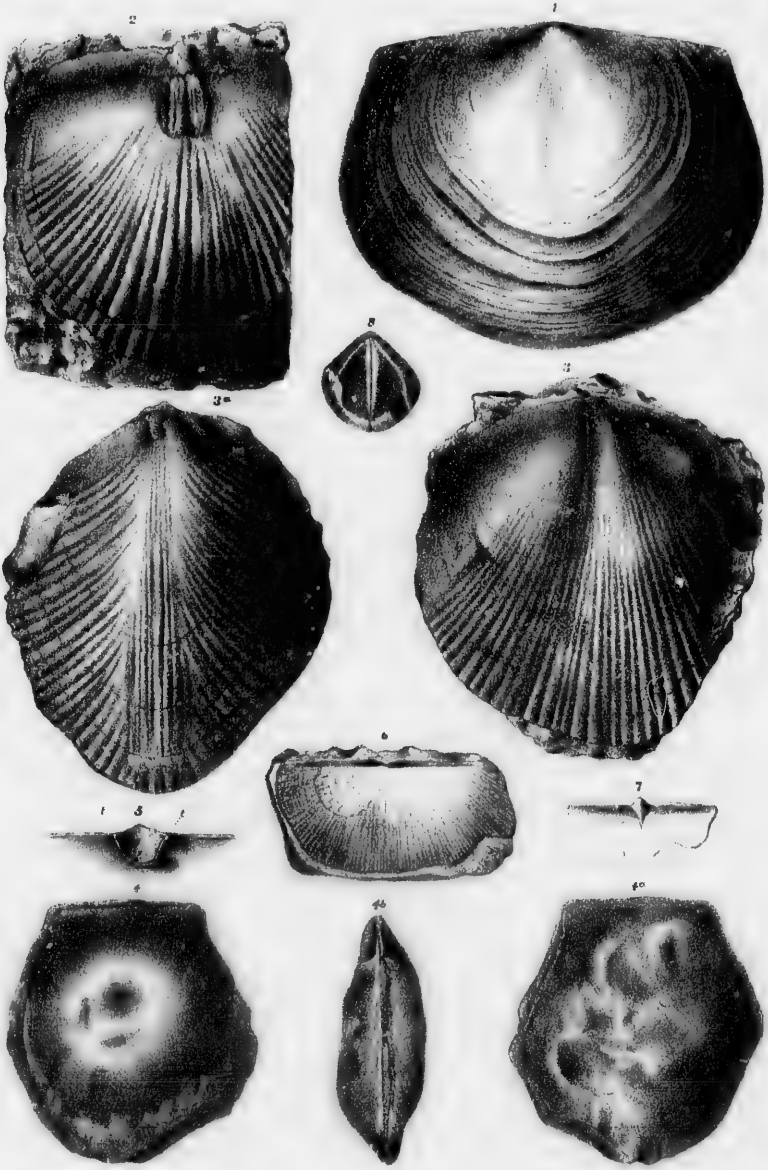
Figure 3. Imperfect ventral valve.

STRICKLANDINIA LIRATA (SOWERBY).

Figure 4. "A fragment of a dorsal valve, from a specimen in the Mus. of Prac. Geol., shewing, besides the adductor impressions, the processes, to which the spiral arms were attached." From Davidson's "General Introduction" Pl. VII.

STRICKLANDINIA GASPEENSIS (page 83).

" 4*a*. A fragment of the ventral valve shewing the chamber.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4a
4c

PLATE VII.

STRICKLANDINIA SALTERII (page 87).

Figure 1. A large specimen slightly restored.

STRICKLANDINIA CANADENSIS (page 81).

Figure 2. An imperfect dorsal valve.

STRICKLANDINIA (undetermined).

Figure 3. This specimen resembles the Swedish specimens of S. LIRATA,
" 3*a*, This is perhaps a variety of S. DAVIDSONII,

STRICKLANDINIA MELISSA (page 89).

Figure 4, Dorsal view.
" 4*a*. Ventral.
" 4*b*. Hinge.

Of the other figures on this plate 5*a*. is a fragment of a ventral valve, from Anticosti, shewing the chamber and two small teeth.

Figure 6. is the "SPIRIFER ? LÆVIS" of J. de C. Sowerby, referred to (ante p. 81) and cited as P. LÆVIS in my original description. Figure 7 is the hinge of S. MICROCAMERUS McCoy.

Figure 8, is P. LÆVIS —the young of P. OBLONGUS, (ante p. 81).

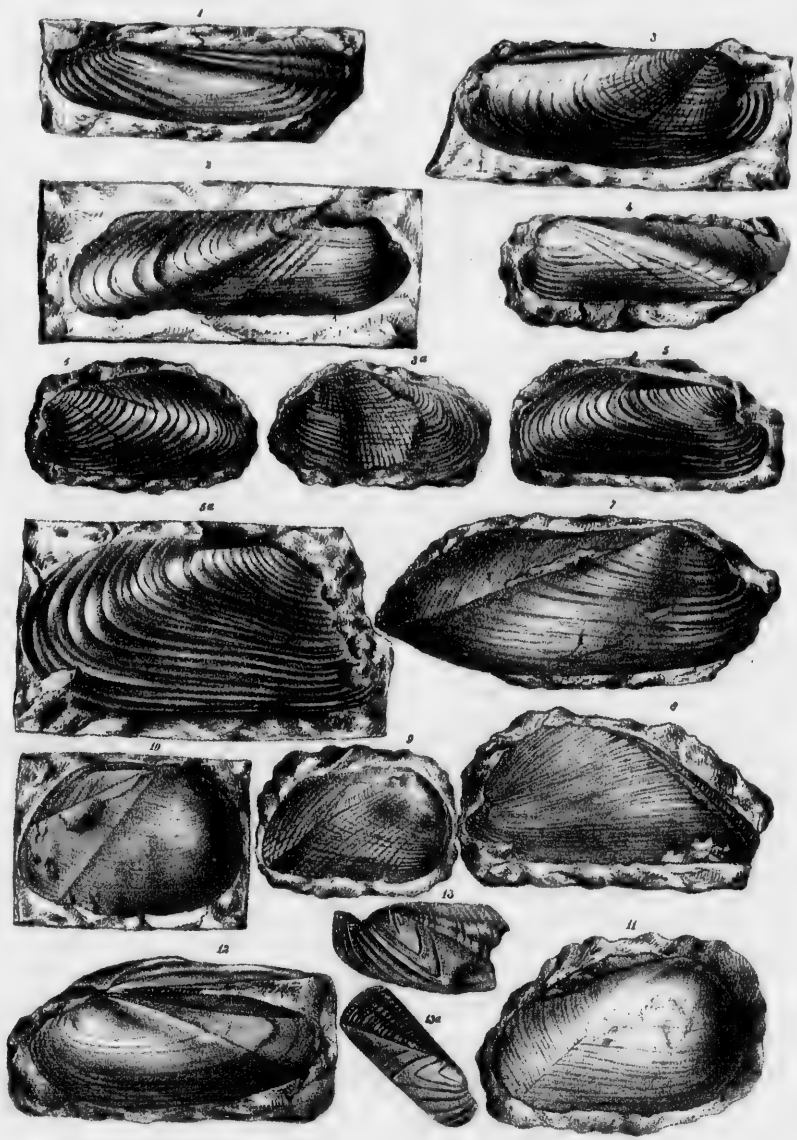

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PLATE VIII.

ORTHONOTA VENUSTA (page 129).

Figure 1. Left valve.

ORTHONOTA INCERTA (page 130).

Figure 2. Right valve.

ORTHONOTA SPECIOSA (page 130).

Figure 3. Right valve.
" 3*a*. Imperfect left valve?

ORTHONOTA SIMULANS (page 131).

Figure. 4. Left valve.

ORTHONOTA ANGULIFERA ? (page 132).

Figure 13. Fragment of left valve. The notch in front of the beak is due to distortion.
" 13*a*. Right valve copied from McCoy, for comparison.

MODIOLOPSIS EXILIS (page 132).

Figure 5. A small right valve.
" 5*a*. A large specimen.

MODIOLOPSIS RUDA (page 133).

Figure 6. Left valve.

GONIOPHORA TRANSIENS (page 134).

Figure 7. Right valve.

GONIOPHORA CONSIMILIS (page 135).

Figure 8. Left valve.

GONIOPHORA BELLULA (page 136).

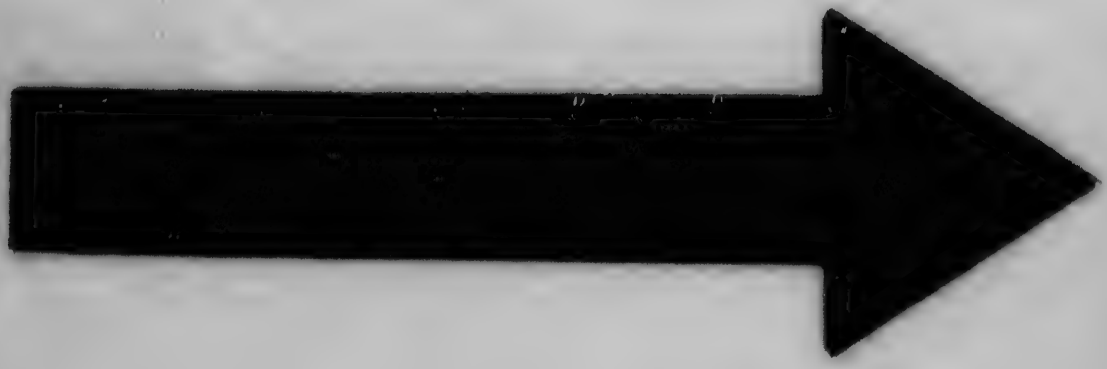
Figure 9. Right valve.

CYTHERODON ? PLACIDUS (page 137).

Figure 10. Right valve, a cast shewing the impression of the teeth.
Figure 11. A variety.

CYTHERODON ? SOCIALIS (page 138).

Figure 12. A specimen with the two valves in connection.



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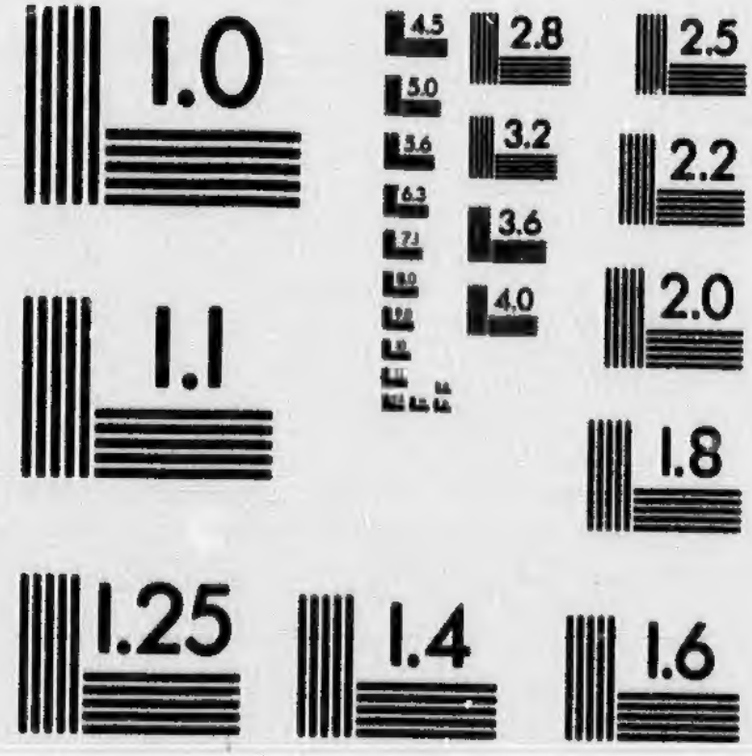

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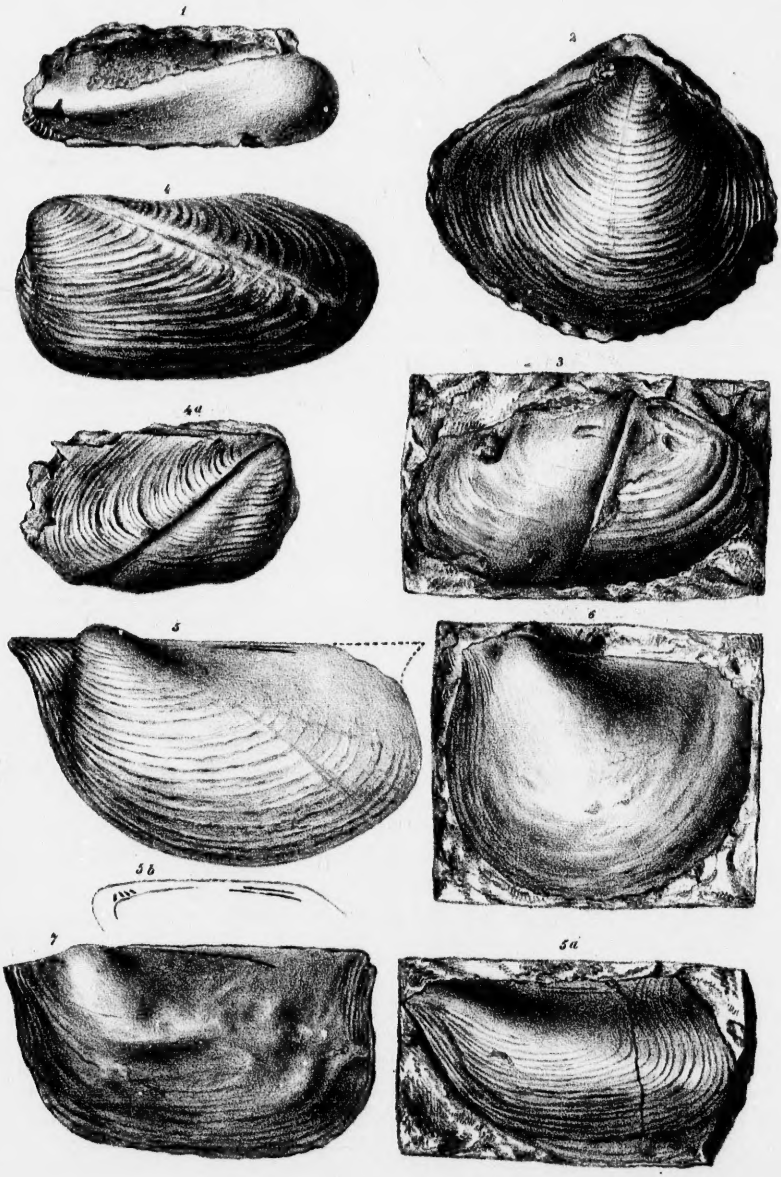

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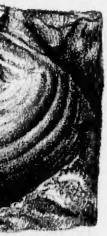

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PLATE IX.

Goniophora mediocris (page 137).

Figure 1. Right valve.

Grammysia remota (page 139).

Figure 2. Right valve.

Grammysia rustica (page 139).

Figure 3. Right valve.

Grammysia acadica (page 140).

Figure 4. Left valve of a large specimen.
" 4*a*. Right valve of a smaller specimen.

Pteronitella venusta (page 142).

Figure 5. A very large specimen.
" 5*a*. A smaller specimen.
" 5*b*. Hinge-line.

Pteronitella curta (page 143).

Figure 6. A specimen of the average size.

Pteronitella oblonga (page 143).

Figure 7. A specimen of the average size.